

MARINE ENGINEERING

INTERNATIONAL

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Remove Shipbuilding Restrictions

NOW that the war emergency which caused the President to forbid American shipbuilders to accept contracts from foreign owners has ceased to exist, why should privately-owned shipyards still be subjected to arbitrary control and prevented from taking foreign contracts? As the weeks go by and no action is taken by the Government on this vital matter, shipbuilders are put in an embarrassing position. During the war millions of dollars were invested in new yards and in the extension of old yards, so that shipbuilding facilities in the United States to-day are vastly greater than in former peace times. In other words, the Government has induced most shipbuilders to increase their capacity enormously, and now it refuses them the privilege of bidding on work to fill up this capacity. In the meantime shipbuilders in other countries are taking orders for all the tonnage they can possibly build for a year or two in advance. A fair share of this business should go to American yards on account of their ability to give quick deliveries and by reason of the large number of men trained in ship work during the war period who are now available in the shipyards, but who will soon be dissipated into other lines of work if the yards are not kept working to capacity. Unless shipbuilding restrictions are promptly removed, the shipbuilding companies will suffer, not only financially, but more especially in the demoralization of their labor.

An Opinion From the Great Lakes

COMPLAINTS regarding the conditions outlined above do not come from the coast yards alone; shipbuilders on the Great Lakes feel the loss of opportunity to take business for foreign account just as keenly, if not more so, than shipbuilders on either the Atlantic or the Pacific. Commenting on the situation in a recent letter, M. E. Farr, president of the American Shipbuilding Company, Cleveland, states:

"It is unfortunate that the restrictions which prevent the building of ships for foreign account by American yards have not been removed long ago, as the embargo has allowed British yards to contract with neutral owners for a large amount of tonnage that would naturally come to this side. I do not believe as things now stand that we can compete with the British shipbuilder, but we have the advantage, particularly in the Great Lakes region, of making quick deliveries and we are also able to reduce costs within the range the neutral owner is willing to pay for early deliveries."

It must not be forgotten that vessel tonnage on the Great Lakes was one of the most important factors contributing to the victory in the war. Without the rapid movement of ore down the Lakes to the steel mills, at transportation costs, which are the lowest in the world, our part in the

war would have been an entirely different story. While the withdrawal of lake tonnage to the seaboard has not seriously affected lake transportation, nevertheless during the war practically the entire shipbuilding facilities on the Great Lakes have been devoted to building sea-going vessels, and during that time existing yards have been greatly expanded, in some cases fourfold or more. To keep the big organizations which have been developed in efficient working order the shipyards on the Lakes should have every opportunity to take advantage of the business offered by the world's markets for shipping.

Second-Hand Vessels Not Wanted for the American Merchant Marine

WHILE no definite action has been taken by the Shipping Board in the negotiations for the purchase of vessels of the International Mercantile Marine flying the British flag, nevertheless this ghost still persists in haunting shipping circles. There is no doubt that British interests are anxious to dispose of these vessels and replace them with new and more efficient tonnage. That this is in line with the established policy of British shipping interests in maintaining the superiority of their merchant marine is shown by a report recently issued in England, which discusses the sale of "older vessels to foreign flags." This report states that "the transfer of large numbers of our older vessels to foreign flags was of great importance in connection with the development of our mercantile marine, and it cannot be overlooked in the consideration of future policy. It means that our shipowners were afforded a ready market for the disposal of vessels no longer satisfactory to them as a preliminary to the purchase of new vessels better suited to their purpose, and that the merchant tonnage of foreign countries as a whole was older and therefore less efficient than the tonnage of the British mercantile marine. It illustrates the process of growth which continually kept the British mercantile marine ahead of its rivals."

No one will question the soundness of Great Britain's policy in this respect, but, knowing the circumstances, why should we handicap our merchant fleet at the outset by acquiring a considerable number of vessels, which, with few exceptions, are old and inefficient and which will require enormous sums of money for their maintenance and operation, when we have at our disposal ample facilities and ability to build new and highly efficient vessels for our purposes? If the United States is ever going to compete in the transatlantic trade, it will be absolutely necessary for us to have the very best vessels that engineering ability can design and construct—not worn-out and second-hand tonnage which others are ready to discard.

Revision of the Shipbuilding Programme

THE suspension of orders for some 15 percent of the total tonnage contemplated by the Shipping Board is explained by Director General Piez, of the Emergency Fleet Corporation, in a reassuring statement as a necessary step in making a complete revision of its entire shipbuilding programme. During the war the Fleet Corporation built all the vessels it could and selected types, not because they might ultimately prove the most useful, but because they could be readily and quickly built in existing yards. Too many vessels of small tonnage were constructed and not enough of large tonnage and greater sea speed. To rectify these mistakes and at the same time to determine a new policy it has been decided to suspend work on all vessels the progress of which justifies the assumption that they can either be cancelled or have other vessels substituted for them with the minimum of expense. The suspension of orders will not cause any appreciable slowing down of the operations in any of the yards for six months or more. Even with such suspensions as are contemplated, there will remain volume enough in most yards to keep them busy under normal speed for from 12 to 18 months. In the meantime investigations will be made to determine the character of vessels that will prove profitable additions to the merchant fleet, and to decide the question whether, under the appropriations thus far made and the authority granted, they are justified in substituting new types of vessels for those suspended.

Efficiency of Reciprocating Engine

IN any attempt to improve the efficiency of marine reciprocating engines it is hardly likely that any fundamental changes will occur, but attention to details is often instrumental in bringing about a considerable economy in operation. One of the most important details and one which is worthy of the closest attention of designers is the arrangement of steam ports. With a view to reducing the clearance volume to a minimum, short, straight, steam ports at the ends of the cylinder can be employed in conjunction with a long valve, this having the additional advantage of reducing the internal surface which is cooled by the passage of the exhaust steam, and upon which the incoming steam will condense. Again, the cylinder covers should join the cylinder as near the face of the cover as possible, and the surface of cylinder cover should be kept as small as possible; in this way, while the clearance volume may be unaffected, the internal surface upon which steam may condense is again reduced to a minimum.

Developing the Port

NEW YORK is a trading city—or it is a ruin. Geography has done everything for it; until now its government has lagged behind private enterprise in modernizing its pier facilities.

Dock Commissioner Murray Hulbert, Director of the Port, has prepared a full programme of development that deserves the sympathetic study of the Board of Estimate. He plans the straightening of the Harlem River, the construction of new ship canals to link Flushing, Gravesend and Jamaica Bays with the Barge Canal, the use of ashes to fill bulkhead land instead of the costly waste of them at sea, the saving of 18,000 miles of navigation yearly by

placing the Sound steamers in the East River, better economy in the use of railroad piers, the removal of Shell Reef, and the construction of new piers which can be rented on a 7½-percent basis.

Some of this plan is the proper work of the Federal Government. But for the most part these development projects are up to New York city—to the city alone, but as trustee of the nation's commerce, as the war has shown. If the whole of the \$100,000,000 needed for dock development is not available immediately, we can at least make a beginning and let no year pass without some substantial progress.

Rivetless Ships

THE welding together of structural parts of ships has, until lately, been objected to on the ground that internal stresses are thereby set up in the material about the surfaces of contact and that the parts thus maltreated cannot be annealed. Further experience with such welding, however, is now considered to have shown that, with proper methods of work, the internal stresses are less formidable than was supposed, and new annealing processes also have been matured.

Let us assume the internal stresses difficulty partly eliminated. The section of the longitudinal girder of a riveted ship is reduced by rivet holes to the extent of about 12 to 14 percent in way of a frame and, practically, by about 16 to 19 percent, a little distance from the frames in way of buttstraps. With ordinary methods of buttstrapping, its resistance to longitudinal bending is reduced by probably more than 25 percent. Admitting that this loss may, by expensive kinds of strapping, be partly made good, we still have perforations of some 20 percent, to set against the supposed weaknesses of the welded connections. But the riveted structures are also heavier by some 8 to 10 percent in straps, and 1½ to 2 percent in rivet heads—say 10 percent in all—than the rivetless ones. Assuming the welded plates made one-tenth inch thicker, so that the structures were equal in weight, we should have an excess, not of 20, but of 30 percent available section of material in the rivetless structure to set against assumed weaknesses in the vicinity of the welds.

The foregoing rough estimate has been based on loss of section in plating due to rivet holes, but the plates in a riveted structure are also very unevenly stressed. A butt connection is practically a spring, and has been found, by careful laboratory experiments made on strakes containing butt-connections, to extend much quicker than the solid material between the butts. This means that in a seaway the points of strake plates just above and just below ordinary end-connections in a strake have to take an undue share of the total work. Since the most heavily stressed points of a structure are the first to give out, this represents a lowering of its capacity for work. A further percentage of an unknown, but not very small amount, must therefore be added to the 30 percent above arrived at.

Experience will soon show the strength or weakness of the rivetless ship, but the experiment is one that deserves to succeed, and it may well result in large savings of weight and of labor. Methods of welding and of annealing will no doubt be still further developed. Provided their past defects can be overcome and processes of application can be sufficiently simplified and cheapened, their application will remove difficulties of many kinds in ship construction. Corner-bar connections will be stronger and more easily made. Girders that cross each other at right angles will become "continuous" in both di-

rections. Watertightness will be attainable in the most difficult places, and the comparison of lines of riveting with stamp-perforations made to "facilitate tearing assunder" will cease to apply.

The Steering of Ships

ALL ships must possess the power to maneuver, but exactly to what extent will depend on the type of the vessel and the use for which it is intended. Although all vessels possess the power to maneuver, it can hardly be said that the majority of ships are really easy to handle. It is true they are handled, and handled effectively, but nevertheless captains often wish that they had more control over their vessels than is given them, even by twin screws and the ordinary rudder.

It will not be without interest to examine what takes place when helm is given to a ship. As the rudder at first goes over, the ship for the moment continues on her course and there is a sudden concentration of water between the rudder and the deadwood aft. This sets up an increase of pressure on both the rudder and the deadwood, which pushes away the stern of the ship in the opposite direction to which the rudder is turning. The ship also moves bodily outwards. The instantaneous effect, therefore, is to move the ship along a course, which is curved in the opposite way to that in which the ship is required to turn finally. In a short time the ship takes up a definite but not really steady swing. This swing is helped by the pressure on the bow, the excess pressure on the deadwood aft being reduced. Shortly after this, the vessel settles down to a steady swing, the pressures on the bow and the rudder turning her, but the pressure on the deadwood aft is now on the opposite side to what it was originally, with the result that it retards the turning of the vessel. Equilibrium must eventually be established when the center line of the ship takes up a definite angle to the direction in which the center of gravity of the ship is traveling. This angle is called the drift angle. The distance between the original course of the vessel and the position of the ship when she is moving in exactly the opposite direction to her original one is called the tactical diameter of the vessel. If this is to be small, the deadwood aft should be well cut away.

When the ship settles down on her turning circle, about the center of which she rotates, there is some point—usually well forward of amidships—on the vessel which only has a motion along the center line, every other point on the vessel really moving in some other direction. This point is called the pivoting point, and the resistance of the various parts under water to turning depends on their distances from this pivoting point. Since the pivoting point is forward of amidships, it follows that the aft deadwood is more effective in reducing turning than the forward deadwood.

When the rudder is first put over, the center of pressure on it is below the center of pressure of the force opposing the lateral motion of the ship and in consequence the vessel at first heels towards the center of the turning circle. When steady motion is established, centrifugal force acts on the vessel through a point generally above the waterline and certainly above the center of lateral resistance. This force is more powerful than the pressure on the rudder, with the result that the vessel heels outwards. Although this is very generally true, it would be possible to conceive of a case where the pressure on the rudder was so great and relatively high, and the center of gravity of the ship, through which the centrifugal force acts, so low, that the ship might heel inwards on the turning circle instead of outwards.

It is, of course, well known that wind will affect the steering of a ship. If she is moving with the wind on the beam, the center of pressure of the wind force on the above-water portion may be forward or abaft the center of lateral resistance of the under-water portion. In any case, helm will have to be carried one way or another to correct the tendency of the wind to turn the ship. This will always decrease the speed of the vessel. In one particular case, it so happened that the center of pressure of wind was abaft the center of lateral resistance, the deadwood aft was cut away, bringing the latter point further forward, making matters worse, so that a good deal of helm had to be carried with a beam wind.

It is generally understood that wind can affect the speed of a ship a good deal. If the wind is directly ahead, it will retard the motion of a ship considerably by direct pressure, although it will not affect the helm. If it is on either bow, it will not only retard the speed on account of its direct pressure, but also by the fact that helm will have to be carried to keep the vessel straight. With wind directly on the beam, helm will always practically be carried, and the speed of the ship will be retarded on this account, although the wind pressure has no direct effect.

Rudders are divided into several classes. The most common form is the ordinary merchant ship rudder, in which the whole area of the rudder is abaft the axis of rotation. For many years the most common type of rudder in war vessels has been the balanced rudder. This takes several different forms. It may be completely balanced and supported by the rudder head and a bottom pintle, or it may be completely balanced and also completely underhung and supported from two points on the rudder stock. There is another form of rudder, described as semi-balanced, in which a small portion only of the rudder area is forward of the axis, the rudder being pivoted on the rudderhead and one or more pintles, the portion of the rudder below the bottom pintle being completely underhung.

The ordinary merchant ship form of rudder remains in general use because it is easily handled, although it is not so economical in form as some of the other types; speeds of merchant vessels being generally small, does not make the rudder unmanageable in size. The steering gear for it has to be larger and heavier than the more effective rudder of the balanced or semi-balanced type; all of its area being abaft the axis, the twisting forces acting on it are much greater than with the latter types. For vessels with cruiser sterns—which includes practically all war vessels—the balanced type of rudder becomes almost a necessity, although in the last few years certain merchant vessels fitted with cruiser sterns have still been given the ordinary merchant type of rudder, and it is doubtful if there is any reason to depart from this form in general practice. If particularly rapid maneuvering is required, there may be some reason for it.

There is no very accurate way of working up the strength of rudders from first principles, as the forces acting on them have never been very accurately determined. Formulae are used for this purpose in certain cases which are admittedly comparative. For the majority of merchant vessels the necessary rudder sizes are all given in the rules of the Registration Societies. It can hardly be said that a rudder is particularly effective in controlling a ship; in fact, if specially delicate maneuvering is required in a vessel, twin screws must always be fitted to assist the rudder. Whether more effective methods will be devised for controlling the motion of a ship must be left for the future to decide, but any improvement on the present system would certainly be sure of a warm welcome.

LETTERS TO THE EDITOR

Systems of Ship Camouflage

The article entitled "Principles Underlying Ship Camouflage" in the February issue speaks with authority and accuracy in so far as it applies to the later development of this subject and the application of the English dazzle system. As it refers to the earlier stages of the art, however, it is extremely inaccurate, and should be corrected.

In the first paragraph, it states that prior to January, 1918, there were five systems in use. At the close of the article it states that after March 1, 1918, the British dazzle system was put into effect by the United States Shipping Board. As a matter of fact, the order requiring the use of the British dazzle system was not issued until May 9, to go into effect on May 20, 1918.

In September, 1917, the protective committee of the United States Shipping Board issued an order, to become effective on October 1, requiring that all ships sailing for the war zone should be camouflaged by one of four systems. These were the Toch, Mackay, Brush and Herzog systems. The Warner system was not developed or approved until lately. In fact, as far as the writer knows, the order of December 9 was the first order recognizing this as one of the approved systems. Mr. Herzog did not evince much interest in the matter, so that the three systems most extensively used were those of Toch, Mackay and Brush, and they were used from October 1, 1917, until May 20, 1918.

Mr. Bement says of these systems that they "were all of the low visibility type; and though in some cases color, and in others black and white were used, it was all for the same purpose, to produce grey at a distance." As this applies to the Toch system, it is absolutely inaccurate. Dr. Maximilian Toch was the first man in America to advance the idea of the disruption and contortion of form by the breaking of the lines with large blotching and contrasting colors.

In May, 1917, a full year prior to the use of camouflage by the Shipping Board, the writer, under the direction of Mr. Toch, camouflage-painted for the Navy Department, the two coast stations at Key West and Pensacola. Three colors were used, a very light gray, a very dark gray, and a dark green. The scheme used throughout was to break up the buildings in large blotches of contrasting colors. This is absolutely a matter of record in the Navy Department and not open to question.

Mr. Toch was one of the first to suggest to the Shipping Board the use of camouflage on ships, and it was due to the previously mentioned work in this line that the system was specified by the Shipping Board. As applied to the ships, the same idea was used. Large blotches of more or less "S" shape were carried diagonally across the hull from the waterline to the deck line, and four colors were used—a light gray, a light pink, a dark gray and a dark green. The bow wave referred to by Mr. Bement was always used, while the false bow was painted on many ships in light colors.

The Toch system varied in one important feature from the British dazzle idea, as originally presented. It was believed that two conditions existed: First, the discovery of the ship at long distance, and second, the shooting at it from a shorter distance. With this idea in view, the superstructure was always painted in very light colors, though the blotch was still maintained to some extent. The dazzle effect was merely applied to the hull, but colors were used which were of low visibility value at

long distances, though contrasting strongly at the shorter distances.

The British dazzle system entirely ignored the question of visibility and depended entirely, as stated, on the contortion effect. It is a fact, too, that of the forty odd ships painted in the Toch system but one was lost, and this at a time when the paint had become ineffective through the making of several trips without repainting.

As regards the Brush system, the writer can only speak from observations, but certainly it was not, as stated by Mr. Bement, a black and white system. The colors used, as far as observation could determine, were a medium gray, a very light gray or white. The idea seemed to be merely to paint out all shadows on the boat with the light color and thus destroy their darkening effect, which, of course, increases visibility.

New York.

A. R. RHETT.

High Development of Structural Materials an Important Factor in American Shipbuilding

The spectacular development of shipbuilding within the last three or four years has had at its base the advantage of structural materials which represented the best results of scientific research in their respective fields. The problem of material and machinery has been, to a large extent, solved by the demands of our regular industries calling for higher and still higher standards of accuracy, durability, etc. Nowadays, material is selected for its usefulness and durability. For example, where an easily damaged pipe of lead was used because wrought pipe would have been difficult to bend to the desired shape, or no convenient facilities for galvanizing were at hand, the difficulty has been removed by the fact that it is now possible to obtain modern wrought pipe that for all practical purposes may be bent to the same radii as lead pipe, without opening in the weld or in the wall, and facilities are provided for galvanizing such parts after bending, either in the yard where a ship is constructed or in an outside shop specializing in such work. Modern pipe, as a matter of fact, has reached as high a state of development (if not higher) as any of the other materials entering into the making of a ship. One manufacturer of pipe gives the pipe special mechanical treatment in manufacture to minimize any tendency to corrosion; the process used is called "Spellerizing," and is given to the smaller sizes of pipe (4-inch diameter and under), because of the relatively thinner walls of pipe of these sizes. This is but one of many beneficial results of scientific research employed in developing wrought tubular products.

Similar efforts and constructive thought have characterized other industries whose products enter into the construction of a modern ship. Steel plates, bars, shapes, etc., are typical of high development, both in a metallurgical sense and in the more obvious sense of accuracy, the wide variety of special shapes obtainable and the general service rendered by the organizations and facilities which produced them. The progress in the development of basic materials, which has occupied a considerable period prior to the sudden development of shipbuilding subsequent to 1915, exercised an accumulated force which relieved the minds of naval architects, engineers and executives of many problems, and has helped, as a consequence, to enable shipbuilders to turn out a durable, seaworthy vessel of 8,000 tons in the short space of a month or two.

Pittsburgh, Pa.

E. E. KELLER.

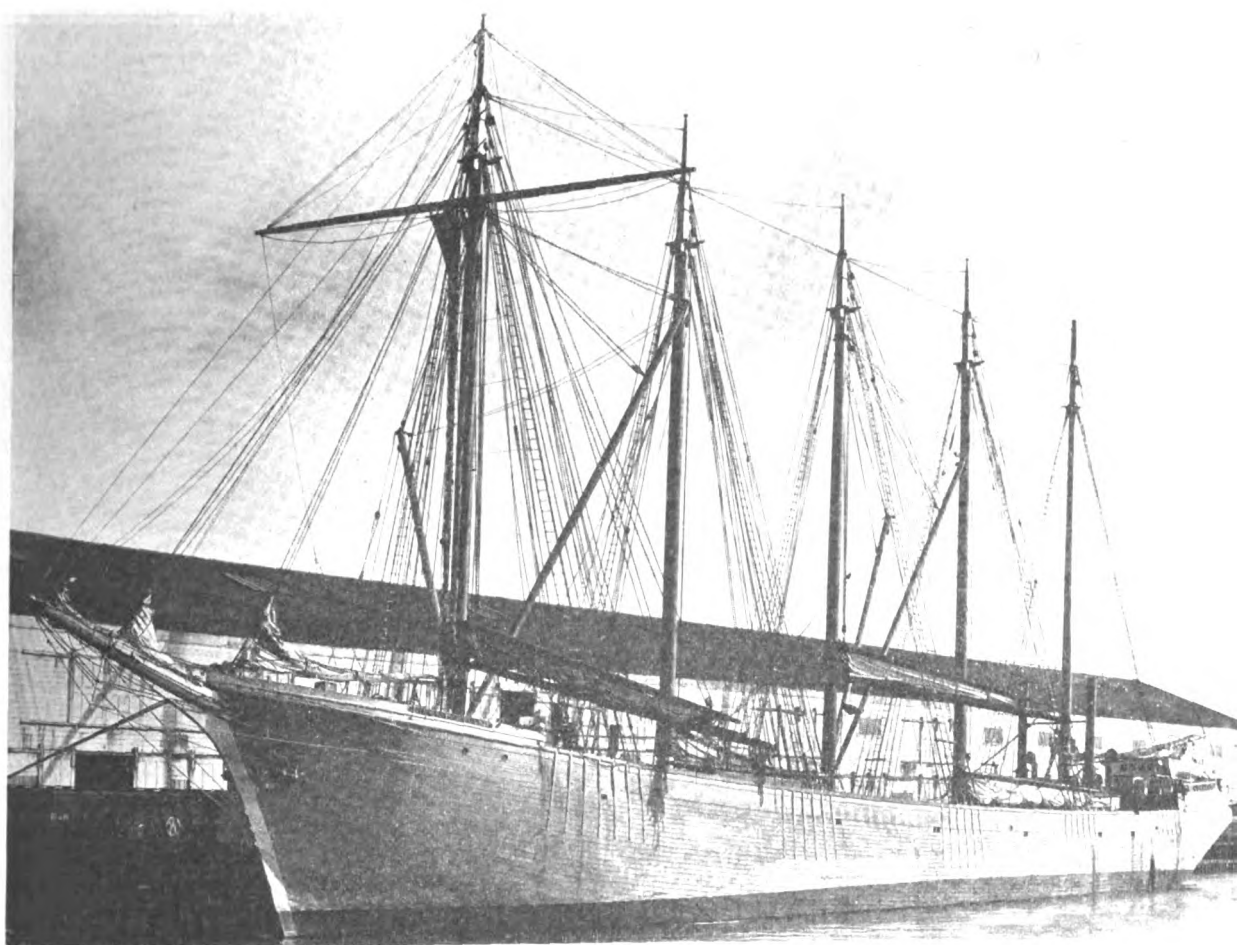


Fig. 1.—Motorship *City of Portland* of the McCormick Steamship Company

Economical Motorships on the Pacific

Records Made by New and Converted Motorships Fitted With Bolinder Oil Engines—Comparison With Steamships—Fuel Savings

BY CHARLES W. GEIGER

THE recent announcement of the McCormick Steamship Company of the saving made by the adoption of the internal combustion engine in the *City of Portland*, amounting to more than 50 percent over that of a steamer of similar size and draft, is calling a great amount of attention to this type of vessel. This announcement was made following the arrival of the motorship at Shanghai after a thirty-five days' voyage via Honolulu from San Francisco, a distance of 6,000 miles.

COST OF OPERATION

The cost of fuel oil to the motorship was \$40 (8/6/8) a day. The cheapest cost of operation for steamers burning oil is \$99 (20/12/6) per day. The *City of Portland* saved about \$15 (3/2/6) in firemen's wages and about 20 percent of her cargo space that would have been needed for coal. She carried lumber, on which the rates reached a total of \$97,000 (£20,000), whereas if a steamer she could have carried a cargo earning only \$80,000 (£16,400). In resumé, the officials estimate that, if normal rates appertained in this cargo, a steamer could have broken even on the voyage and the motorship have earned \$20,150 (£4,125).

The *City of Portland* has not been tied up for repairs for a year and a half, and recently made the run from San Francisco to the mouth of the Columbia River in three and a half days, despite unfavorable weather conditions. The vessel has the following dimensions: length 276 feet, breadth 48 feet, depth 21 feet, approximate deadweight tonnage 3,500. She is equipped with twin 320-brake horsepower Bolinder engines, type "M-11" and has a lumber carrying capacity of over 2,000,000 feet.

MOTOR OIL TANKERS

Following the unusual demonstration of the *City of Portland*, the Philippine Vegetable Oil Company is placing a fleet of oil tankers in operation between San Francisco and the Orient, all of which will be operated by the Bolinder type of internal combustion engine. The first of this fleet of oil tankers, the *Nuuanu*, has recently completed her second round trip between San Francisco and the Orient, carrying out a cargo of petroleum oil and returning with a cargo of cocoanut oil from Manila. The *Nuuanu* was equipped with a 320-brake horsepower "M-11" Bolinder engine in 1916. Previous to this installation

she had been towed from port to port. The *Nuuanu* is 211 feet in length, 34 feet in breadth and 19 feet 6 inches in depth. She was originally an iron sailing vessel, but was converted to an oil tanker by the General Petroleum Company, from whom she was purchased by the Philippine Vegetable Oil Company.

The Philippine Oil Company has recently purchased a second vessel, which is being converted into an oil tanker, and is being powered with a pair of 320-brake horsepower Bolinder engines. Two additional vessels, each equipped with a pair of 500-brake horsepower Bolinders, will soon be placed in operation by the same company in transporting petroleum oil to the Orient, returning with coconut oil.

FIRST BOLINDER-ENGINE VESSEL ON THE PACIFIC

The first vessel on the Pacific coast to be equipped with a Bolinder engine was the motor tug *Marie L. Hanlon*, owned by the Hanlon Shipbuilding Company, of Oakland. This engine is of 160-brake horsepower and gives the tug a speed of 9¾ knots. It has been in continuous operation since being installed, the tug being engaged continuously day and night towing barges with most satisfactory results.

The engine installed in the *Marie L. Hanlon* was the experimental and testing engine that had been brought to San Francisco in August, 1913, for experimenting with different qualities of California asphaltum fuel oils. Having quickly found quite suitable California fuel oil, very satisfactory and convincing trials were conducted by the factory engineer, proving conclusively that internal combustion engines of the Bolinder type could be operated in a practical and dependable manner with various California asphaltum base fuel oils of the inexpensive varieties. Since then, large mineral oil companies, such as the Standard Oil Company of California and the Union Oil Company of California, have marketed a product known commercially as "Colol" and "Diesol," respectively, of about 24 degrees gravity, which is giving excellent re-

sults and with which the Bolinder engine has since been operated without any apparent deleterious results over a period of several years.

FUEL OIL SUPPLIES

Supplies of fuel oil suitable for internal combustion engines of the Bolinder type are now held in storage by the Standard Oil Company of California at all principal coast ports and the Hawaiian Islands. Elsewhere oil companies in ordinary times have supplies on hand of good oil. The refueling of Bolinder boats fitted with sufficient tankage is exceptional, as most of the wooden boats have fuel capacity sufficient for a round voyage or up to about 12,000 nautical miles. In steel hulls the double bottom and water ballast tanks supply more than ample storage for fuel oil.

Serious consideration has been given to the proper installation of the engines, and from the experiences gained on the various boats and minor improvements made in the completed installation, the chances of mishaps and breakdowns have been so minimized that no serious trouble has arisen under present conditions as has been shown by an examination of engineers' logs on various boats. Numerous instances of non-stop runs of 30 to 40 days have been shown by the engineers' logs.

LONG NON-STOP RUNS OF MOTORSHIPS

As a proof of the ability of motorships to make long trips without replenishing the supply of fuel oil, the full powered motorship *Sierra*, owned by the E. K. Wood Lumber Company, might be mentioned, which, since being in commission, has made numerous voyages between Astoria and San Pedro, and other complete voyages to the Western Coast of South America, taking lumber cargoes as far south as Valparaiso and returning with cargoes of nitrate. This vessel is 210 feet in length, 15 feet in depth and 42 feet beam, with a deadweight tonnage of 1,875. The engine-room equipment consists of twin 320-brake horsepower Bolinder engines, with one 8 and one 15-horsepower stationary engine for electric lighting and general purposes.

On account of the low consumption of fuel oil, the *Sierra* was able to make the voyage to any of the South American ports and return without having to deviate from her course to call at ports for the purpose of replenishing the supply of oil at exorbitant rates, which has to be done in the case of steamships.

FOUR MOTORSHIPS OF THE GRACE COMPANY

A considerable amount of interest is centered in the four motorships that have been placed in commission by Messrs. W. R. Grace & Company. They are the *Santa Elena*, *Santa Isabel*, *Santa Cristina* and the *Santa Flavia*.

The propelling machinery of these vessels consists of two 320-brake horsepower Bolinder oil engines, fitted with air injection and an improved oiling system, which has resulted in considerably reducing the consumption of lubricating oil. The machinery is located in a large engine room amidships, which has a most pleasing and roomy appearance, the engines being firmly secured on strong cast iron foundations.

The auxiliary machinery consists of one 15-brake horsepower Bolinder engine, direct connected to a 10-kilowatt generator, and one



Fig. 2.—Philippine Vegetable Oil Tanker *Nuuanu*

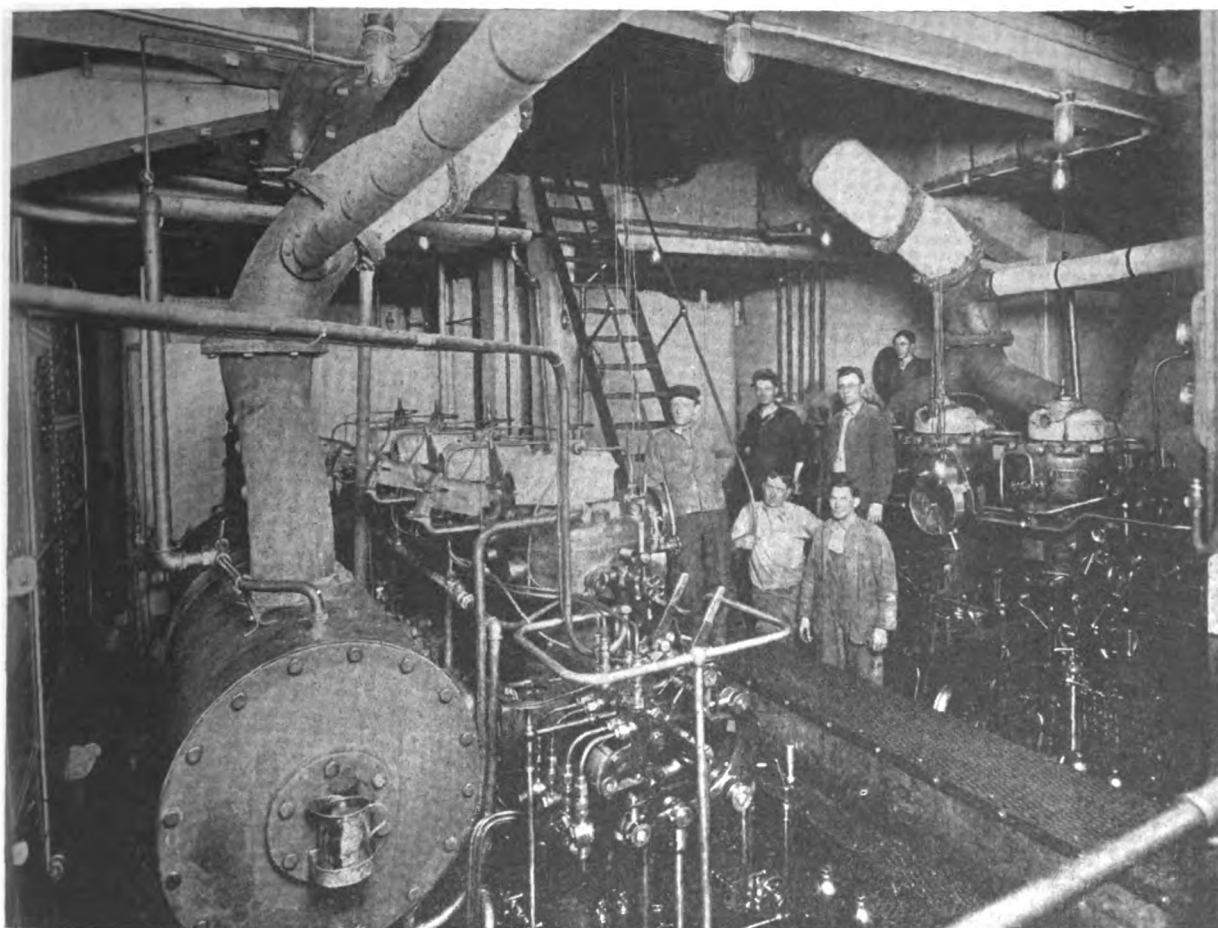


Fig. 3.—Engine Room of Motorship Sierra

rotary pump of 2,500 gallons' capacity, and one 8-horsepower Bolinder engine connected to a 5-kilowatt generator and rotary air compressor. The refrigerating plant consists of one 1-ton Brunswick motor-driven ice machine, the ship being fitted with 600 feet of refrigerating space for ships' stores.

The main fuel supply is carried in four steel tanks just forward of the engine room with a total capacity of 1,320 barrels, and these, together with four steel tanks having a combined capacity of 412 barrels, and two 20-barrel day tanks in the engine room, give a total capacity of 1,770 barrels, or sufficient for nearly 80 days' running.

MODERATE-SIZED MOTORSHIPS MORE ECONOMICAL THAN STEAMERS

These ships are excellent examples of the possibility of moderate-sized vessels equipped with fuel-oil engines. The extensive radius over which they are able to travel without having to stop for refueling, combined with their fuel economy, give them an immense advantage over the ordinary steamer, to which may be added the increased cargo space obtained by the elimination of steam boilers.

These four ships were carefully designed and built with all the conveniences of a large modern liner. The dimensions of the *Santa Elena* and *Santa Isabel* are: length 225 feet, breadth 42 feet, depth 29 feet, cargo capacity about 2,000 tons on 18-foot 6-inch draft. The *Santa Cristina* and the *Santa Flavia* are 235 feet longer than the two first named vessels, all other dimensions being about the same.

AUXILIARY MOTORSHIPS MAKING GOOD RECORDS

The two auxiliary motorships, *La Merced* and *Oronite*, are of very fine models and are making some very fast passages. These vessels are operated by the Standard Oil Company. Each of the vessels is equipped with two 160-brake horsepower Bolinder engines. The *La Merced* completed a trip to Melbourne and return, carrying case oil on the outward voyage and returning with a cargo of grain, the outward voyage being made in the good time of 48 days, and the return voyage in 53 days. The distance by steamer route to Melbourne is 6,966 miles, so that the time occupied in making the voyage out in 48 days for a vessel of such moderate power must be considered excellent. The return voyage, which was made by the route south of the Islands of New Zealand, covered a distance of nearly 8,000 miles, and the time, 53 days, must be considered extremely creditable.

The first vessels on the Pacific Coast to be equipped with Bolinder engines as auxiliary power were the steel sailing barks, *Annie Johnson* and *R. P. Rithet*, owned by the Matson Navigation Company and engaged in the San Francisco and Hawaiian trade. These vessels, which are approximately the same size, having a capacity of about 1,800 tons cargo, had installed in them two 160-brake horsepower engines. They had been in service about 30 years at the time this installation was made in 1916, and had been in the Hawaiian trade for nearly 8 years, averaging about six round trips per year, while propelled by sail power alone. These voyages cover the time taken up in making various calls to the different ports

in the Hawaiian Islands, the ships being towed from port to port.

EARNING CAPACITY OF VESSELS INCREASED 50 PERCENT

Since the installation of auxiliary power, the above ships are now able to make about nine round voyages per year, showing a gain of nearly 50 percent in the earning capacity, and of course they are able to make the trips between the different island ports under their own power, saving a considerable amount in towage expenses. The average time consumed in making the voyage between San Francisco and the Hawaiian Islands is about twelve and one-half days.

The auxiliary motorship *R. P. Rithet*, after having been in commission for about one year, was destroyed by fire. Since the installation of the power machinery in the *Annie Johnson*, the cost of repairs to her machinery has not exceeded that of a similar steam plant.

FUEL AND LUBRICATING OIL CONSUMPTION

On a voyage between San Francisco and Honolulu to Mahukona and return to San Francisco, the following amount of fuel and lubricating oil was used by the *Annie Johnson*. Total running time of engines 29 days, total consumption of fuel oil 289 barrels, total lubricating oil used 400 gallons, approximate total cost of fuel and lubricating oil for the round trip \$550 (£113).

The motorship *Ozmo*, formerly the three-masted schooner *Hugh Hogan*, was built in 1904. In 1916 the owners decided to convert her into an auxiliary motorship and at the same time reconstruct the vessel, adding a shelter deck, which has considerably increased her cargo capacity.

The power installation consists of two 160-brake horsepower Bolinder engines driving twin screws. This is the equivalent of approximately 450 indicated horsepower and is sufficient to maintain a speed of 8 knots with the ship fully loaded.

The *Ozmo* has a length of 160 feet, depth 9 feet 8 inches, beam, 38 feet 8 inches. One of the best records

made by this vessel was a voyage to Wellington, N. Z., from San Francisco in 39 days and returning in 45 days.

ADVANTAGES OF OIL ENGINES OVER STEAM

The advantages of the internal combustion engine over steam, even when fitted with fuel-oil burning apparatus, are very marked, and in some instances the cost of the engines has been saved within a period of 24 months. Other advantages are as follows:

1. Cargo space saved (eliminating boilers, fresh water, and one-half to two-thirds bunker space of fuel-oil tankage).
2. Smaller engine-room force (stokers or firemen eliminated).
3. Eliminating the necessity of calling for fuel, saving extra port charges, delays and extra cost of fuel and water at out-of-the-way ports.
4. Fuel consumption about one-third of boiler consumption.
5. Fresh water not required for main engines.
6. "Raising steam" and standby costs eliminated.
7. Lower repair bills, no boilers to clean or constant repair to same, furnaces, floor plates, etc.

Taking it for granted that merchant ships and steamers are operated for the purpose of profit or carrying cargo at a minimum cost, the hull that can carry the most cargo at the lowest cost at the usual tramp speed at about an equal outlay of capital is the most economical. Trans-Pacific trade is the one that the Pacific coast is most seriously interested in. Developing and extending the export and import business with the Orient, Australia, South America and the Pacific South Sea Islands should be the endeavor of all Pacific coast merchants and shipping companies, and to handle overseas goods and products, tonnage is absolutely necessary. On account of the distances, difficulty has been experienced in finding economical ships; an ordinary tramp of 5,000 tons deadweight, inclusive of bunkers, on the same voyages, can carry only 3,000 to 4,000 tons of actual freight-paying cargo on account of the space taken up by bunkers or weight of fuel oil.

Charts for Use in the Design of Propelling Machinery for Usual Type of Cargo Ships

Curves Compiled for Finding the Horsepower, Boiler Surface, Condenser Surface and Quantity of Cooling Water Required

BY JAMES L. HAYNES, M. E.

THE following set of charts is compiled for the use of engineers who are handling designs of power plants for the usual type of cargo ships. Many inconsistencies are met in comparing sizes of boilers, engines and condensers for various arrangements of machinery in use, and as engineers base much of their work on existing designs they have to estimate many factors basing opinions on conflicting precedent. These curves have been worked out to facilitate the determination of consistent results, considering as many primary variables as it seemed practicable to include and assuming fixed all factors that are likely to be nearly the same on all ships in the class considered.

For any new ship, it is assumed that the displacement, speed, type of main engine, type of boilers, kind of fuel and rate of firing are known. With this much informa-

tion we are able to decide the horsepower, boiler surface, condenser surface and quantity of cooling water quite accurately from the charts; and, having found this information, the other auxiliary machinery depending on these sizes is easily calculated.

The chart shown in Fig. 1 is based on the formula given by Rear Admiral C. W. Dyson, U. S. N., in his book on propellers, with constants supplied to suit our work.

$$\text{Shaft horsepower} = \frac{D^{2/3} V^3 \times .92}{230},$$

where

D = tons displacement.
 V = speed in knots.

The Admiralty coefficient 230 has been chosen as applying to the cargo ships we are to deal with, which have a block coefficient of about .78.

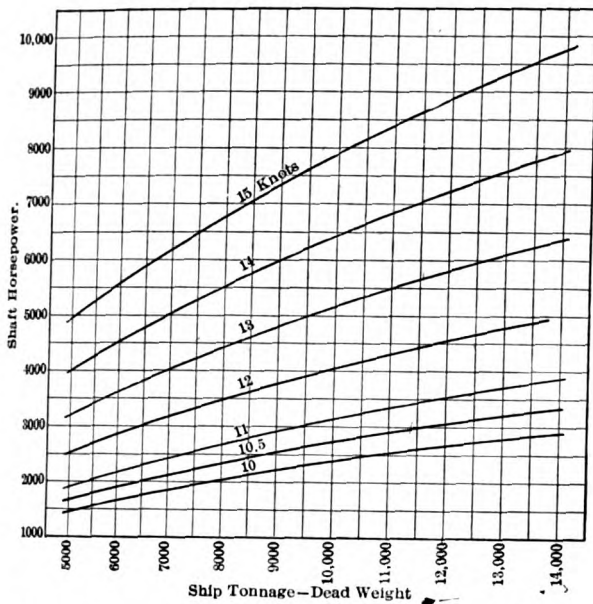


Fig. 1.—Power-Speed Curves Standard Cargo Ship. Block Coefficient 0.78

With this chart it is easy to pick off the power for ships included within its range, when the tonnage and speed are given.

The number, sizes and styles of the auxiliaries, as well as the type of main engine or turbine, will guide in deciding what to allow for total steam consumption per shaft horsepower for the ship. This will probably fall between 14 and 22 pounds, and the chart shown in Fig. 2 gives the total steam per hour by reading down from the intersection of the line for shaft horsepower and the proper rate of consumption. There seems to be no way of fixing the rate of steam consumption except by comparison with trials of similar ships.

If the boilers are to be coal fired, we next use the chart

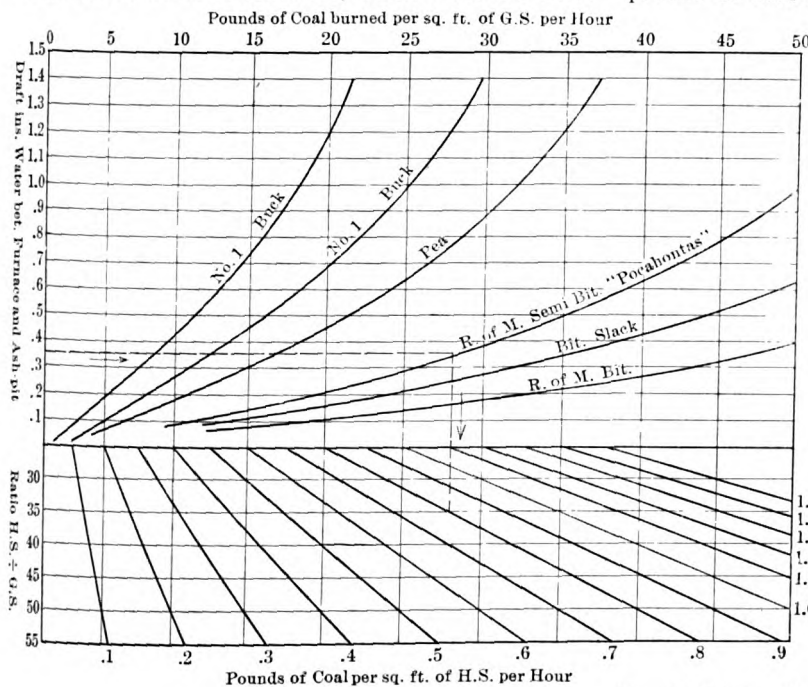


Fig. 3.—Relation Between Rate of Combustion and Required Heating and Grate Surface for Different Boilers and Coals. Boiler Efficiencies Assumed to Be Equal

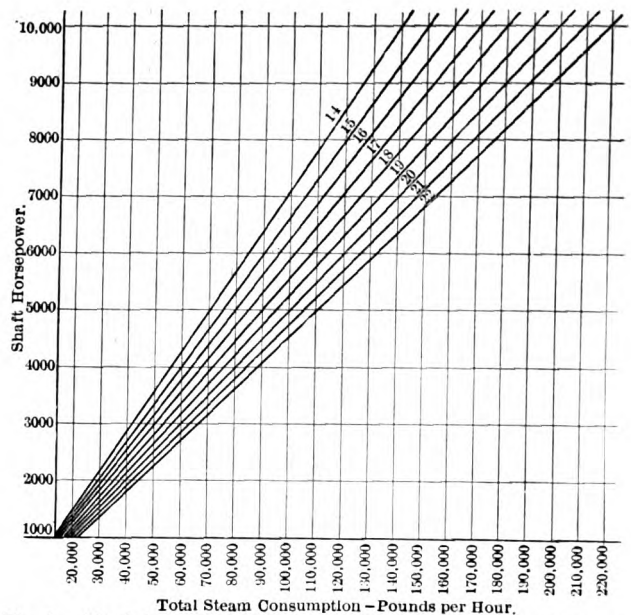


Fig. 2.—Total Steam Consumption for Ships Where the Total Steam Per Shaft Horsepower is Known. For Class of Ships Considered it Varies from 14 to 22

shown in Fig. 3. This chart is taken from Dr. Charles Edward Lucke's "Engineering Thermodynamics," and shows the relation between draft and rate of burning different kinds of coal. By reading across from the proper amount of draft to be used to the curve for the kind of coal used and then down to the horizontal line representing the ratio of heating to grate surface, we obtain the reading of pounds of coal per square foot of heating surface per hour.

With this value from Fig. 3 we use the chart shown in Fig. 4, taken from Dr. Lucke's "Thermodynamics," to determine the rate of evaporation for the boiler. The method is evident. Read up from the proper value for pounds of coal per square foot of heating surface per

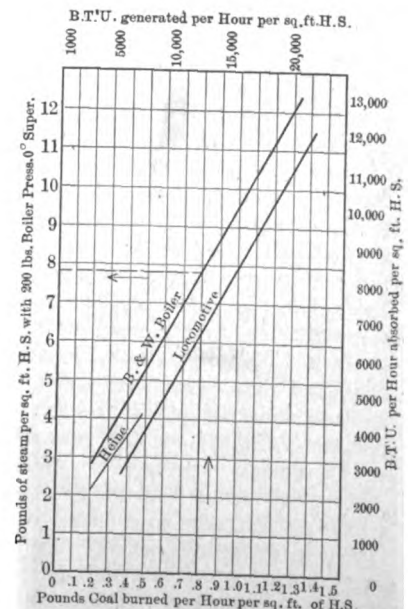


Fig. 4.—Relation Between Rate of Combustion and Capacity, Navy Boilers, Arranged for Reading Pounds of Water Evaporated Per Square Foot of Heating Surface Per Hour With 160 Degrees of Feed Water. Curve is Average of Several Boilers with Pocahontas Coal

hour, as found by Fig. 3, to the proper boiler curve; then read across to the value of pounds of evaporation per square foot per hour. It will be noticed that this chart applies for Pocahontas coal, which represents usual

few picked cases for condenser design on cargo ships. The application of these curves needs no explanation.

CONCLUSION

Since the machinery installed in many ships to-day is bought from different places building a number of standard sizes of equipment, it follows that the sizes actually used in such cases will be the nearest available size to that required by the designer. This probably accounts for some of the inconsistencies noticeable in the proportions of power plants for cargo ships. It is better, therefore, to base estimates on practice as compiled and made into a set of uniform curves than to base specifications on the sizes of machinery installed in certain ships where the determining factor may have been the availability of certain sizes for ready delivery at a low price rather than the service required of the units.

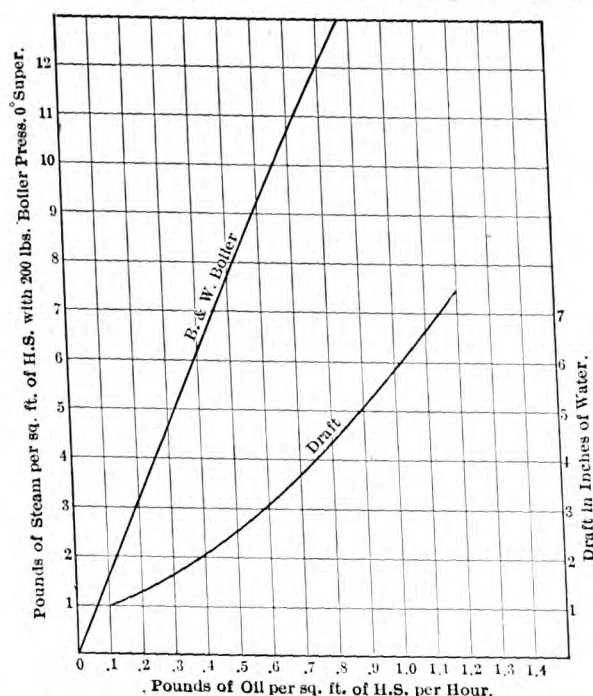


Fig. 5.—Relation Between Rate of Combustion and Capacity for Oil-Fired Marine Boiler

good grades of soft coal, and the values of pounds evaporated plotted at the left of the diagram apply for 200 pounds pressure, which is usual practice for cargo ships to-day. Dr. Lucke does not give an analysis for Scotch boilers, but the curve he gives for a locomotive boiler probably applies closely for a Scotch boiler.

Having already determined the total steam consumed per hour, we divide by the pounds generated per square foot of boiler surface and thus obtain the total boiler heating surface required for the ship.

If the boilers are to be oil fired, we use the chart in Fig. 5 in place of those in Figs. 3 and 4. This chart is taken from Rear Admiral C. W. Dyson's text on "Marine Engineering," and is used in exactly the same manner as Fig. 4. It gives us the rate of evaporation corresponding to the rate of firing which is to be used on the ship, and thus determines the required boiler surface in the same manner as stated for the case of coal firing.

The two main factors of importance for the condenser are taken care of by Fig. 6. They are condenser surface and quantity of cooling water. The curves are based on formulas for transfer of heat in condensers, assuming 7 degrees temperature rise, and include such constants as will locate the curves so as to fit a

A Sea Going Concrete Barge

The launch of what is claimed to be the lightest sea-going concrete boat in the world has taken place at the yard of the Concrete Seacraft Company, Limited, on the Mersey, at Fiddler's Ferry, a village three miles from Warrington, about twenty miles from the sea. The barge, of 250 tons, designed for the local wheat-carrying trade, is 95 feet long, 21 feet 4 inches beam, and 8 feet draft. It was constructed of a large number of small matured units of concrete prepared beforehand, and then erected on the slip in much the same way as the frame and plate of an ordinary steamship. The units of concrete were then fixed together by means of diagonals of round steel, which bind the whole structure together. The *Elmarine* is the lightest concrete boat for her size which has been built receiving Lloyd's classification. The thickness of sides is $1\frac{3}{4}$ inches, instead of $3\frac{1}{2}$ inches, which is the requirement of Lloyd's for boats built on any other method.

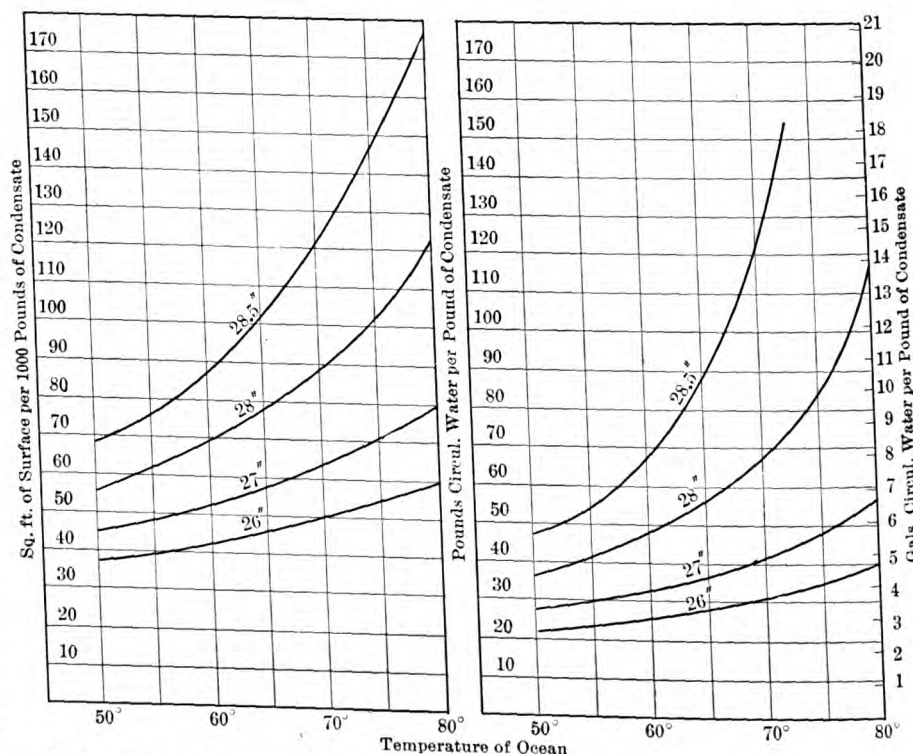


Fig. 6.—Curves for Main Condensers Adapted from Formulæ on Page 475 of A. S. M. E. Transactions for 1916 Which Relate to Marine Work. Use 75 Degrees for Ordinary Designing

Machinery for American Merchant Vessels

Basic Considerations Governing Selection of Economical Type of Machinery—Research Work Under Government Control Urged

BY COMMANDER H. C. DINGER, U. S. N.

THE United States is building a large merchant marine and will probably continue to build merchant vessels on a large scale for years to come. The success of these vessels commercially will be dependent to a very large extent upon whether their machinery installations are satisfactory and whether they are those most suitable for the particular type of vessel and for the service in which the vessel will be placed.

There are numerous types of marine machinery from which to choose, and a wise selection from among these types may make the difference between success and failure of the United States in operating merchant vessels in competition with foreign nations. In making the selections of types of machinery, many things should be taken into consideration. Due weight should be given to fuel economy, weight, space, first cost, operating cost, cost of probable repairs, number and quality of the operating personnel required, availability of the fuel in the regions the vessel will operate in, reliability, safety, availability of parts of machinery decided upon. The following are some of the different types of modern marine machinery that may be considered:

Oil engines of the Diesel or semi-Diesel type, either four cycle or two cycle.

Steam reciprocating engines with either oil or coal and Scotch or watertube boilers.

Combination of reciprocating engines exhausting into low-pressure turbines, with any of the variety of boilers mentioned.

Direct-connected steam turbines.

Turbo-reduction gears.

Electric drive.

There are also questions regarding the use or non-use of superheat, different condensing systems, the character of drive for various auxiliaries, such as pumps, winches, dynamos, etc., steam pressures employed and use of feed heating and air heating appliances.

FUELS—COAL VERSUS OIL

The first question is to consider the type of fuel, that is, coal or oil. Both fuels are available in variable degree and at variable prices. Roughly, 200 gallons of oil (or 2/3 ton) are equal to one ton of coal. In certain regions, on this basis, coal is cheaper; in others, oil. On the Atlantic coast, coal is slightly cheaper, while on the Pacific and the Gulf, oil is cheaper. As long as there is an available supply of either fuel, it is natural and proper that both should be employed, and each, as far as possible, where it has the advantage. To build only oil-burning vessels would be a serious mistake, because for certain routes coal would be considerably cheaper.

The following are some general rules that may be considered as applying:

(a) Vessels plying between ports where coal is cheaper than oil should be designed for the use of coal. This would take in vessels leaving North Atlantic ports and trading with Northern Europe or in the coasting trade on the Atlantic.

(b) Vessels plying between North Atlantic ports and South America and South Africa would also be justified in using coal, provided they carry enough for the round trip, but oil would be equally suitable.

(c) Vessels plying between Gulf ports and South America or South Africa should use oil.

(d) Vessels operating from the Pacific coast, for long-distance voyages, except possibly to Australia, should use oil.

With the different conditions as to supply of fuel and the fact that both coal and oil are available, it would be a mistake to build all vessels for one type of fuel. To get the best results from the available supply of fuel, each should be used in the places where it has the advantage from the viewpoint of economy and availability. The availability of oil fuel may change materially, due to the opening up of new fields. One of the chief sources of this fuel will be Mexico, and there are prospects of additional fields being developed in Colombia and Venezuela. As far as the American continent is concerned, there is prospect of more oil fuel becoming available, hence, vessels using oil fuel for commercial purposes may well be on the increase.

VESSELS USING OIL FOR FUEL

The first question to decide here is whether the oil engine or the steam engine should be used. The answer is both, depending on the type of vessel and her field of operation. The advantage of the oil engine (Diesel) is in economy, but for very large powers, this type of engine is too heavy and too bulky, hence, where we use high power, we will have to pay for it and use the steam engine. Where economy is of special importance for vessels making very long trips to regions where fuel is expensive and for powers within the limitations of the oil engine, the oil engine should hold the field. This would apply to coasting vessels as well as overseas craft.

Of course, both types, within their field, are developed so that they may be considered as being able to work with equal reliability. Doubt as to the reliability of the oil engine within its proper limitations as to size, weight and speed of revolutions, is now a thing of the past.

With this field divided between the oil and the steam engine, there is also the chance for healthful competition and development, the steam engine being developed to secure better economy and the Diesel engine to reduced weight and increased reliability at higher powers. Distributing the building of the machinery among the oil engine and steam engine builders is also a desirable feature, since it distributes the work more widely and creates a condition where more shops may be engaged in the field of building marine engines.

THE OIL ENGINE

The particular field for the Diesel oil engine is on slow and medium speed freighters designed to operate on long voyages and to regions where fuel may be difficult to obtain. For vessels of about 1,500-3,000 horsepower, a very reliable and especially economical installation can be produced.

These oil-engined installations will require but one-half the fuel that the best steam installations do. Less attendants are required and repairs will probably be less than with a steam plant. For the above powers, a four-cycle engine is recommended, chiefly for the reason that it is simpler. Fresh water for piston cooling is entirely

feasible, though successful salt-water cooling systems are also available.

In an installation of this character, a donkey boiler should be supplied capable of being operated by the engine exhaust gases at sea and by an oil burner in port. This boiler should be large enough to operate the steering engine and anchor engine and certain of the winches and pumps. Oil-engine generators should be supplied to operate certain of the auxiliaries and a portion of the winches. It should be arranged that when in port, but not engaged in loading or unloading, the vessel would not require the boiler to be in operation. For this reason, bilge and sanitary pumps should be electrically driven. The steering engine and whistle could have a connection to the starting air bottles so that they could be operated at sea in case the boiler is shut down.

The above arrangement would call for two small oil-engine generators to supply current for the electric-driven pumps for lighting and for electric winches. The boiler would supply steam for the steam-driven pumps and auxiliaries, steering engine, anchor engine, distilling and heating system. A small auxiliary condenser should be fitted to handle the exhaust of steam-driven auxiliaries.

The reason for using steam for the anchor engine, steering engine and certain pumps, while electricity is used for some of the other pumps and auxiliaries, is economy and reliability. If all auxiliaries, including the anchor and steering engine, are to be electrically driven, a generator of considerable size would be needed, and these auxiliaries would be more expensive than their steam counterparts. Some generators are needed for lights, while a boiler is needed for distilling and heating. Therefore, as in any case, a boiler and also an electric generator is to be installed, the auxiliaries can be divided between the two to very good advantage.

When all the winches are needed and in raising anchor, the boiler would be in use. When simply waiting in port, the boiler could be let down and the generator only kept in operation for lighting and bilge and fire purposes. At sea, the boiler can be operated by the waste heat in the exhaust gases, thus adding to the economy of the plant. Heating, distilling, steam for cooking, etc., could thus be accomplished out of waste heat. Boilers operated in this way have been successfully used on numerous merchant vessels and also on United States submarines.

The Diesel engine would have special advantages for vessels trading from Gulf ports or the Pacific coast of the United States to South America, from the Pacific coast to Alaska and the Orient, and from the Atlantic coast to South Africa and to Mediterranean ports. Sufficient fuel for the return voyage can be carried, and any difficulties connected with refueling avoided. On vessels making these long voyages, the ability to cut down the crew to about one-half that required for a steam plant will be a large factor in reducing running expenses.

For low powers, a four-cycle engine with no piston cooling will answer. For powers above 1,000 horsepower, the four-cycle engine with piston cooling would be used. For higher power than 3,000 horsepower, a two-cycle engine should be used. It is believed that powers up to 10,000 can be realized in a twin-screw, six-cylinder outfit. Such installations could be employed on large, medium-powered vessels with the special advantage of securing great economy of fuel.

At the present stage of the game, powers above 10,000 horsepower are not considered suitable for oil engines on account of the space and weight required.

The Diesel engine would be suitable to both the slow cargo boat and also the medium speed combined passen-

ger and freighter. Since a very large part of the ocean tonnage will be made up of vessels of this character, it is plain to see that the field of the marine oil engine is a large one and that the sooner the oil engine is generally adopted and developed by the United States merchant vessels for this particular field, the sooner will the United States reap the benefit thereof. The Diesel engine enables the crew to be cut down, but calls for a higher class of engine operatives. Hence, this will enable the oil-engined vessel to compete with vessels manned by lower paid but larger crews.

The United States is particularly well suited for the full development of the oil engine on account of the ready supply of oil on both coasts. Another advantage is that on account of the wide use of automobiles and gasoline (petrol) engines, there are a very large number of men who have some training in connection with the operation of oil engines. It is from the internal combustion engine mechanics of the country and from watch or instrument makers that the operators for marine oil engines should be recruited. The fact that the oil engine installation of a moderately powered vessel is really a clean, mechanical job, free from the dirt and inconvenience of the usual steam plant, but one which requires a high grade of operating intelligence, should serve to attract a very good class of mechanics to this marine field. The engineers of oil-engined vessels should develop into an aristocracy of intelligence among marine operating engineers. Diesel engine mechanics must be more careful in their work than the steam engineering mechanics. For this reason good results are likely to be secured by getting hold of men who have experience in instrument making or other fine mechanical work.

OIL VESSEL—STEAM MACHINERY

This type of vessel has its principal field in high powered and high-speed vessels. The types of engines may be, (1) direct-connected turbines; (2) combination of turbines and reciprocating engines; (3) reciprocating engines, or (4) turbo-reduction gear. The latter seems to be the most suitable, particularly for high powers. The combination is about as economical and may be used for medium powers. Except for rather low powers, the reciprocating engine would probably not be used.

Turbo-gearing is lighter, more economical, and occupies less space than any of the other types, and is also cheaper and easier to build; hence, it is natural to expect that gearing will almost monopolize this field.

Watertube boilers appear to be more suitable for oil fuel than do Scotch boilers. Superheaters are advisable as a means of securing economy and there is no trouble to be expected in operating them. They ought to be in as general use on ships as they are in power plants on shore.

For high-speed passenger and freight vessels there is, of course, at present, no real competitor of the turbo-reduction gear. These turbo-gears, when using superheated steam, give a higher economy than anything else except the oil engine, and are the lightest installations.

Several innovations in the power plants of these vessels might be adopted with great advantage. The following may be mentioned:

(a) Use of centrifugal feed pumps.

(b) Use of condensers of the destroyer type with scoop circulation. This gives a much lighter installation and is more efficient at high speeds.

COAL-BURNING VESSEL

This may vary from the smallest to the largest. The type of engine to be used will depend to some extent on

the powering. For low powers and low speed, there is still quite a field for the reciprocating engine, but for high powers, the turbo-reduction gear would be the answer. For medium powers, the combination of turbine and reciprocating engine might be used.

The reciprocating engine should be confined to powers below 2,000 horsepower. The reciprocating engine is easy to operate and repair and can be taken care of by less intelligent attendants and can stand more abuse than the turbo-reduction gear unit. Owing to this fact, the reciprocating engine should still be installed in the small cargo steamer.

For low powers, the well-designed reciprocating engine is nearly as economical as the turbo-gear, but for high powers the turbo-gear has an advantage of 10-15 per cent in economy.

For the low-powered coal-burning cargo boat, the Scotch boiler appears to be the most advisable. Superheat is recommended, except for very low powers or where it is desired to have the installation as simple and as cheaply constructed as possible. For the higher powers, the large tube watertube boiler would be desired. Its principal recommendation is that it weighs less and there is little practical limitation to the size of the unit that may be installed.

RECIPROCATING INSTALLATIONS

A modern up-to-date reciprocating engine should be designed to secure the best practical economy in steam consumption. To this end a fairly high cylinder ratio of low pressure to high pressure should be employed to enable the expansion of the steam to be properly carried out. Also, cylinder clearances should be reduced to the lowest practical limit. Either a quadruple or a triple expansion engine may be employed, and if a steam pressure of more than 200 pounds is carried, the use of a quadruple expansion engine would probably be justified in units of over two thousand horsepower. The use of steam jackets does not appear to be justified, but special attention should be paid to lagging and covering of steam radiating surfaces. The efficient draining of receivers and the use of these drains in feed heaters should be provided for. Good sized units should use forced lubrication, but this installation would not be justified on small, slow-moving engines.

The use of feed heaters and the utilization of all possible heat in drains should be arranged for. Efficient condensers and air pumps capable of producing a vacuum of 28 inches of mercury with 60 degrees F. water should be required. It is about as easy to have an installation that will produce 28 inches of vacuum as one that will give but 24 inches. For large installations, steam seals on the low-pressure rods and valve stems are recommended for the purpose of keeping out air.

With an efficient cylinder ratio, one that will give 12-14 expansions, on a triple-expansion engine, well designed valves and low clearances (8-12 per cent) and with good condensing apparatus and feed heaters, a reciprocating engine should be able to give a horsepower for 13.5 to 14 pounds of water and 1.3 pounds of coal per horsepower. This result is almost the same that would be secured with turbo-reduction gear, and it looks as if the reciprocating engine, efficiently designed, should still hold on in this field for years to come. There are many shops rigged and ready to build these reciprocating engines, whereas the gears have to be built in shops especially equipped.

AUXILIARIES FOR STEAM MACHINERY

Considerable change may be expected in the construction of steam auxiliaries with the advent of the turbo-

gear sets. To begin with, a very good vacuum is desired, hence condensers and air pumps to produce this are required. Reduced cost and lightness can be obtained by adapting the condensing installations that have been successfully developed for United States destroyers. The condensers are of the curved expanded-tube type and the air pumps have a combined wet and dry air pump or wet-air pumps used in conjunction with Parsons augmentor. For high speed and high-powered vessels, the use of scoops for circulating water offers similar advantage to a merchant vessel that it does on a destroyer or scout. The use of the scoop is probably not advisable until the speed is as high as fifteen knots. An auxiliary circulating pump is, of course, fitted on a by-pass of the injection pipe to supply circulating water at low speeds or when backing. With scoop condensers, it is also necessary to have only a single-pass condenser and to have the condensers in the fore and aft line.

Condensers of this type can be considerably smaller than the types that have ordinarily been fitted on merchant vessels. Condensers of destroyers have shown their ability to condense 25 pounds of steam per square foot of surface, the vacuum being 28-29 inches of mercury. Though these condensers are most efficient and light, they are also the simplest and easiest to build. For high-powered vessels, turbine-driven centrifugal feed pumps are recommended, and centrifugal pumps can be used for ballast and bilge service.

For air-pump service, the combined wet and dry reciprocating air pump represented by the Weir dual and the Blake & Knowles twinplex, or a wet-air pump in conjunction with a Parsons augmentor, appear to be the simplest and most reliable installations. Though ejectors in combination with condensate pumps are available, these devices are as yet not fully developed and are not yet in general vogue on vessels.

LUBRICATING SYSTEMS

With reduction gears, the lubricating system is the most important matter and the success of the gear is dependent largely upon the adequacy and the efficient operation of the lubricating system. The De Laval Company have gone extensively into this subject of lubrication of gears and have designed a lubricating system adjusted to conditions on merchant vessels which is very complete. The Emergency Fleet Corporation has required an installation similar to this to be fitted for reduction gear sets on its vessels. With an efficient lubrication system there will be little repairing and overhauling required in connection with the reduction gear sets. Practically all troubles encountered with reduction gears are centered in defects in arrangement or handling of the lubrication system.

BOILERS

The first question to consider is the kind of fuel. Shall coal or oil be used? If oil is used, a watertube boiler would appear to be more advisable, for the following reasons: It is lighter and can be built in larger units, and the regulation of burners and their installation on a watertube boiler is easier than on a Scotch boiler. The oil-burning installation is also more easily made. There is little dirt, no ashes, etc., and for this reason oil-burning watertube boilers are not as much subject to deterioration as are coal-burning watertube boilers. To burn oil to the best advantage, heavy, forced draft is required. This does not go well with a Scotch boiler.

If we are to use coal, there is much more in favor of the Scotch boiler, and in certain classes of work it would be better to use it. The advantage of the Scotch boiler

is its reliability under hard conditions of service. It will stand abuse and neglect that the watertube boiler will not stand. It is fairly easy to build, and the ordinary run of marine firemen know how to operate it. Its disadvantage is its weight. For slow-speed cargo boats of small power, the weight does not count for so much, and therefore for coal-burning marine installations of about 3,000 horsepower and less, the Scotch boiler should be used. For this power, two or three boilers give a convenient size from both an operating and a construction point of view.

For high powers, say above 10,000 horsepower, the Scotch boiler should not be used on account of the extra weight required and the number of boilers that would have to be installed. For intermediate powers, around 5,000 horsepower, either the watertube or the Scotch boiler could be employed.

Steam Pressure.—For Scotch boilers, either with reciprocating engines or turbines, pressures from 160-200 pounds would appear advisable. For watertube boilers, 200-260 pounds would be considered best. There is no advantage in going to higher steam pressure. The advantage in economy can be secured by using superheat.

Superheat.—Superheat should be used on both Scotch and watertube boilers, except for very low-powered installations. With reciprocating engines, the initial temperature of steam should not exceed 500 degrees F. and with turbo-reduction gears 550 degrees. Higher temperatures than these would require the use of special material in piping and fittings, which may present some difficulty. Ordinary steel and good bronze will handle 550 degrees F. without any trouble. A very considerable increase in use of superheat on boilers for merchant vessels may be looked for.

Air-Heating Devices.—Howden's system for coal-burning Scotch boilers is advisable, and some system of air heating for coal-burning watertube boilers can often be installed to advantage. For oil-burning watertube boilers, using the mechanical system of oil burning, air heating arrangements are hardly justified.

Oil-Burning Systems.—For large watertube boilers, the mechanical system using heavy F. D., $\frac{5}{8}$ -inch of water, and an oil pressure of 50-200 pounds, gives the best results. For small powers and where Scotch boilers are used, lower air pressures should be used.

Steam atomization is not recommended for any marine installation on account of the waste of fresh water. Suitable mechanical systems for oil burning have now been fully developed.

Forced Draft Blowers.—High-speed fans, driven by steam turbines, are recommended over either motor drive or small reciprocating engines.

Standardization of Auxiliaries.—If the steam and electric auxiliaries for our merchant vessels could be standardized to a greater extent, so that practically all these auxiliaries were manufactured in large numbers according to standard patterns, the cost of manufacture would be very much reduced, the apparatus would be more highly developed, and operations would be much easier and better understood. This particular thing is something that the Emergency Fleet Corporation can promote, since at present it controls the design and requirements for most of the United States merchant vessels building.

SUMMARY

It will be seen that the principal innovations of recent development are:

Extensive use of turbo-reduction gears and of oil engines.

Use of superheat.

Extension of the use of watertube boilers, particularly where oil is used for fuel.

Use of better and improved condensing apparatus with all types of steam machinery.

More general and more efficient use of feed heaters.

More general use of small steam turbine for driving auxiliaries.

The following economical results may be expected from the various types of machinery:

TYPE OF MACHINERY	Pounds Per Shaft Horsepower, Oil	Pounds Per Shaft Horsepower, Coal	Pounds Water Per Shaft Horsepower	Horsepower Per Sq. Foot Heating Sur- face
Turbo-reduction gear, 5,000 horsepower and up. Water- tube boilers, superheat.	.85	1.3	11-12	1
Reciprocating engines, Scotch boilers, superheat.	1	1.4	13-14	1.8
Reciprocating engines, Scotch boilers, no superheat.	1.1	1.55	13.5-14.5	1.8
Oil engines, four-cycle.	.45-.48			
Oil engines, two-cycle.	.48-.52			

By far the largest items of expense in operating vessels are the fuel and the pay of the engineer's force. Hence, successful designs of machinery will have as some of their principal aims the securing of economy and the possible reduction of the operating force. Heretofore, first cost has too often been the deciding factor. The operating expenses in a few years will make up the slight differences where lower first cost has caused the sacrifice of economical design. Where many vessels are being built according to the same designs, the importance of extreme perfection in the design is vastly increased, for then a defect or an advantage are both multiplied many times. Conservation of fuel and of operating labor are the particular fields that the design of our merchant ships machinery should exploit. If this is done successfully, it will give the United States merchant marine a vantage point. If it is neglected, it may mean the inability of the United States merchant marine to keep up with foreign competition.

It is believed that research work into this question of economical design and experimentation should be undertaken by the government in order that the best possible advancement in practical improvement may be made and that our shipping industry may secure the advantage of this. Private enterprise cannot afford to go into this research and experimentation to any great extent, and the development of the best possible practice in marine engineering is a public matter, something belonging to the country as a whole. Just as the roads and canals are public utilities, whose efficiency is of vital general interest, so the efficiency of our operation of the highways of the sea is a matter that should receive the attention of the Federal government and its support in development.

Considerable research and some experiment in engineering has been done by the navy. Much of this is of great value to the merchant marine, but the operation of merchant vessels also has certain problems that are outside of naval work, and for this reason there should be some public agency to look after these interests. Such a field would naturally fall to the Department of Commerce, which already has several offices which, if enlarged and strengthened, might take over this work (Bureau of Navigation and Steamboat Inspection Service). Pioneer work in this field is also being done by the Society of Naval Architects and Marine Engineers, and by the American Bureau of Shipping; but the importance of building and holding on to an efficient American merchant marine is so overpowering that further steps to perfect and increase these institutions are imperatively necessary.

Efficient Layout and Management of the Plate and Angle Shop in Shipyards

Size of Shop Determined by Speed of Conveying Material to Ships—Arrangement of Shop and Method of Storing Materials

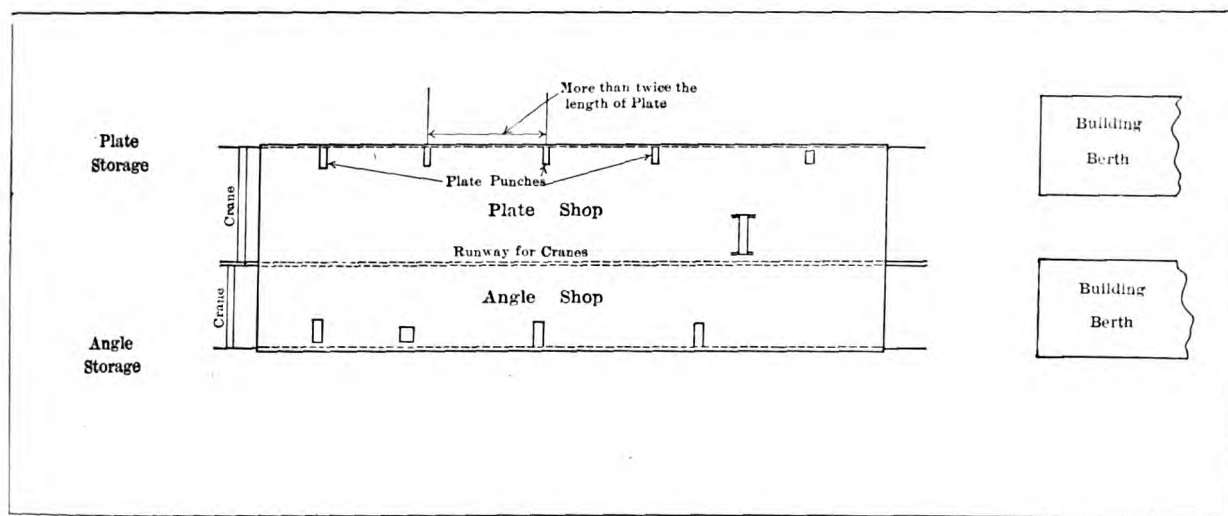
BY G. F. S. MANN, B. S.

TO lay out and manage a plate and angle shop efficiently, it is necessary to have a clear understanding of the building schedule. That is to say, the number of tons of plates and angles that have to pass through the shop each working day must first be determined. It is customary in small yards to lay the keels in rotation and not simultaneously. Thus if twelve hulls are to be built in one year, and if only one building way is to be used, it is

determines the size of the shop for a predetermined daily output per ton.

ORDER OF HANDLING THE WORK

There are three classes of work to be considered, namely, straight, cold bent work, and furnaced work. The number of plates that have to be furnaced is so small that they should be bent to shape and laid off in another part



Sketch to Show General Method of Laying Out Shop

necessary to have enough punches, shears, etc., to prepare the steel for one ship in one month.

THE TRANSPORTATION PROBLEM

One factor that is of the highest importance in determining the size of the plate and angle shop is the transportation problem. Whatever conveyance is used to take the steel from the shop to the hulls must be loaded at the shop, taken to the ship, unloaded there and then brought back empty to the shop. The time taken for this cycle of movements limits the number of trips that can be made in a day. Therefore, if the number of conveyances is for any reason limited, an example of such a reason being a single track, thus preventing the return of empty cars to the shop while loaded ones are being sent to the ship, the number of punches and shears, etc., must be proportionately increased so that there is always sufficient steel ready to be loaded at each return of the empty conveyance to keep up the daily output of tonnage.

Dividing the total daily tonnage as called for by the schedule by the total number of trips that all the conveyances can make in a day gives the number of tons that must be carried at each trip. Care must be taken, however, that an over-accumulation of finished pieces does not collect and so interfere with the efficient handling of the machines.

From the above it will be seen that the transportation from the shop to the hulls is one of the factors which

of the yard before they are sent through the plate shop, so that the special processes applied to them do not interfere with the straight work. Every plate and angle should be worked from the storage racks through the shop towards the hull, and not a single piece of material should be carried away from the ships, or back-stepped, as it is technically called.

LAYOUT OF THE SHOP

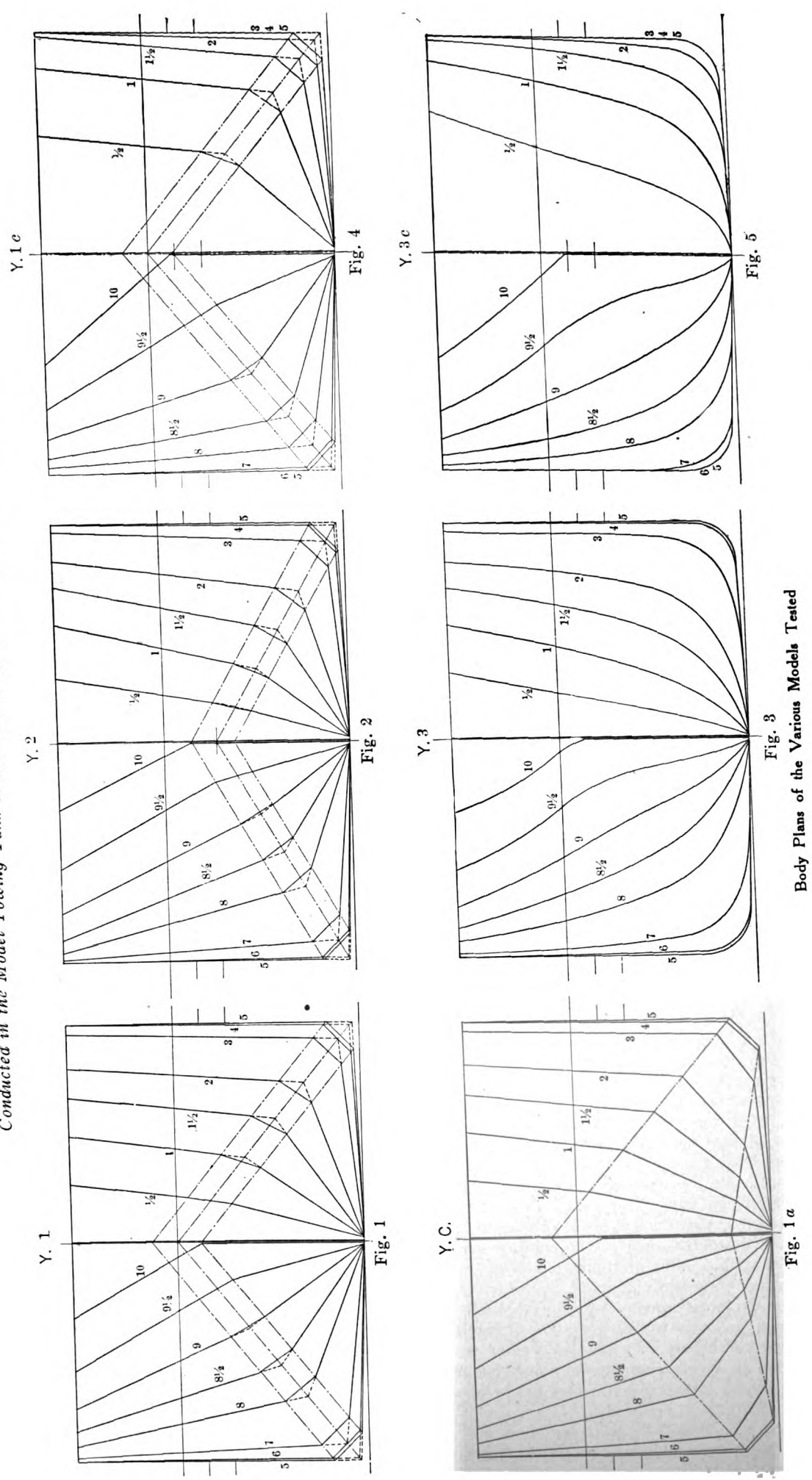
The plate and angle shop should be a long, narrow building with its longitudinal axis perpendicular to the waterfront when it is designed as a single unit to serve only a few hulls at a time. Angle shears and punches should be arranged down one side of the building and the plate shears and punches down the other side, so that the plates and angles can never get in each other's way. This important point is frequently overlooked in some of the smaller shipbuilding plants.

In laying out the shop, care must be taken that the plate punches are farther apart than twice the greatest length of plate which will be handled. Unless they are so arranged, there will be a considerable loss of time, owing to one machine being blocked by the end of the plate which is being punched in the adjoining machine.

Not only must the machines be properly spaced, but they must be arranged in the order in which the different operations are done, so that the plates and angles can be worked through the shop without being back-stepped. The

EXPERIMENTS ON SIMPLIFIED SHIP FORMS

Conducted in the Model Towing Tank at the University of Michigan, Ann Arbor, Mich.



Body Plans of the Various Models Tested

building may be divided longitudinally by a row of columns, the side on which the plates are handled being wider than the side in which the angles are handled, in the proportion of about seven to five.

The easiest way to handle the plates and angles in the building is by means of two overhead cranes, one of which is installed in each side of the shop. The runways for these cranes should extend out of both ends of the shop, so that the same cranes may pick up material at the storage end of the shop, then bring it into the shop, and, finally, carry it out of the other end when it is ready to be taken to the ship.

The plates and angles must be stored in such a way that any piece of material which may be needed at any particular time can be picked up without having to handle any other pieces first. Plates should be stored on "A"-shaped racks, the end of each rack being clearly marked for the kind of plate to be stored there. The plates are then unloaded from the cars onto their own racks.

The storage yard should be served by a cantilever crane for carrying the plates and angles to the shop, but a long boom locomotive crane may be used. The sketch shows

the arrangement of the plate and angle shop as described in this article.

If the plates are not put on racks which are properly labeled, but are piled flat in heaps, several plates may have to be lifted off the pile before the one which is wanted is reached, thus causing great delay, which in turn means unnecessary loss of time and money. If the plates were to be stored flat in heaps it would be necessary to have them loaded onto the cars at the rolling mill in the order in which they would be used in the shipyard; that is, the plate that is wanted first for the ship should be put at the bottom of the car, the others being loaded on the car in the order in which they will be needed. When these plates are unloaded in the shipyard the plate that is wanted first would then be on the top of the pile.

It will be readily seen that such an arrangement of storage, although theoretically possible, could never satisfactorily work out in practice.

In conclusion, it might be mentioned that the steel should be ordered on such a schedule that it will arrive at the yard in as short a time as is practicable before it is needed for the ships.

Experiments on Simplified Ship Forms*

Comparative Resistance of Ordinary Shipshape and "Straight Frame"
Models—Factors in Design Which Tend to Increase Resistance

BY PROFESSOR H. C. SADLER AND T. YAMAMOTO

THE question of the simplification of ship forms is one that has received a good deal of attention during the past year. In their anxiety to produce a simple form from a structural standpoint, a good many designers, not familiar with ships, have ignored entirely the question of economical propulsion. During the past year some experiments upon "straight frame" forms have been conducted in the tank at the University of Michigan, and the results are thought to be of sufficient interest to place the same on record.

The main object of the experiments was to determine what difference in resistance existed between an ordinary shipshape form and one in which the curved form of the frames was replaced by straight lines. No particular attempt was made to develop the best possible form, but the main features of the two types were kept constant.

The diagonal line representing the corner was in all cases made a straight line, with the view that, if the bilge corner were cut off, this would facilitate construction.

The body plans shown in Figs. 1, 2, 3, 1a, represent the various forms used. The models were 10 feet long and 16 inches wide. For each particular type the following characteristics were kept constant, viz., length, breadth, draft, displacement (at load draft with the corner cut off), the curve of sectional areas (and hence prismatic coefficient), and the shape of the waterline.

The models were tested at three different drafts covering the usual range.

In each case the model was first tried with the sharp corner, and latterly this was removed.

Two different slopes were given to the bilge diagonal to determine the effect of this feature.

In one case also the lower knuckle was given a small enough slope to keep it within the double bottom; the top

knuckle in this case remaining the same as in form Fig. 1. The following table gives the characteristics of all the forms tried.

Y. 1 (CORNER OFF)					
Draft, Inches.	B/d		0 Percent	10 Percent	20 Percent
7	2.285	{ Long. coeff.....	.674	.707	.739
		{ Block coeff.....	.655	.688	.718
		{ Mid. coeff.....	.973	.973	.973
		{ Waterline coeff.....	.760	.784	.808
6	2.66	{ Long. coeff.....	.662	.697	.728
		{ Block coeff.....	.641	.675	.706
		{ Mid. coeff.....	.969	.969	.969
5	3.2	{ Long. coeff.....	.646	.681	.716
		{ Block coeff.....	.621	.655	.688
		{ Mid. coeff.....	.962	.962	.962
Y. 2 (CORNER OFF)					
7	2.285	{ Long. coeff.....	.674	.708	.739
		{ Block coeff.....	.655	.688	.718
		{ Mid. coeff.....	.973	.973	.973
		{ Waterline coeff.....	.760	.784	.808
6	2.66	{ Long. coeff.....	.662	.697	.729
		{ Block coeff.....	.641	.675	.706
		{ Mid. coeff.....	.969	.969	.969
5	3.2	{ Long. coeff.....	.646	.683	.716
		{ Block coeff.....	.623	.659	.691
		{ Mid. coeff.....	.965	.965	.965
Y. 3					
7	2.285	{ Long. coeff.....	.673	.708	.737
		{ Block coeff.....	.655	.688	.718
		{ Mid. coeff.....	.974	.974	.974
		{ Water Line coeff.....	.760	.784	.808
6	2.66	{ Long. coeff.....	.661	.696	.728
		{ Block coeff.....	.641	.675	.706
		{ Mid. coeff.....	.970	.970	.970
5	3.2	{ Long. coeff.....	.647	.683	.718
		{ Block coeff.....	.623	.658	.692
		{ Mid. coeff.....	.964	.964	.964

* Paper read at the twenty-sixth general meeting of the Society of Naval Architects and Marine Engineers, Philadelphia, November 15, 1918.

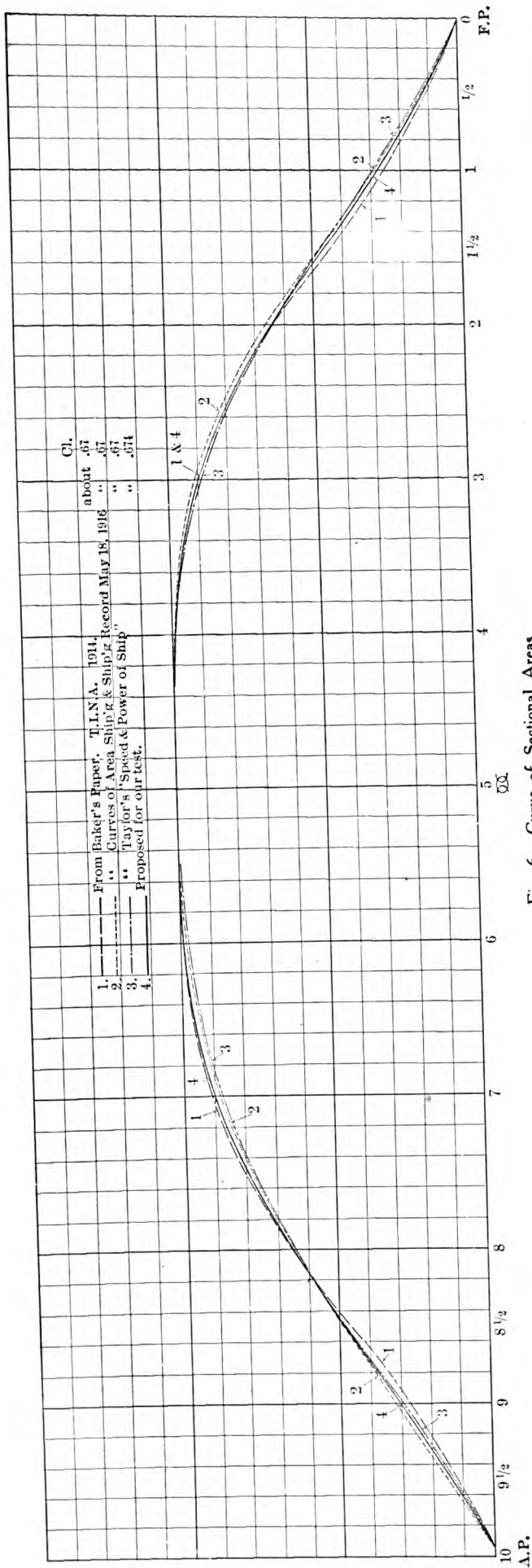


Fig. 6.—Curve of Sectional Areas

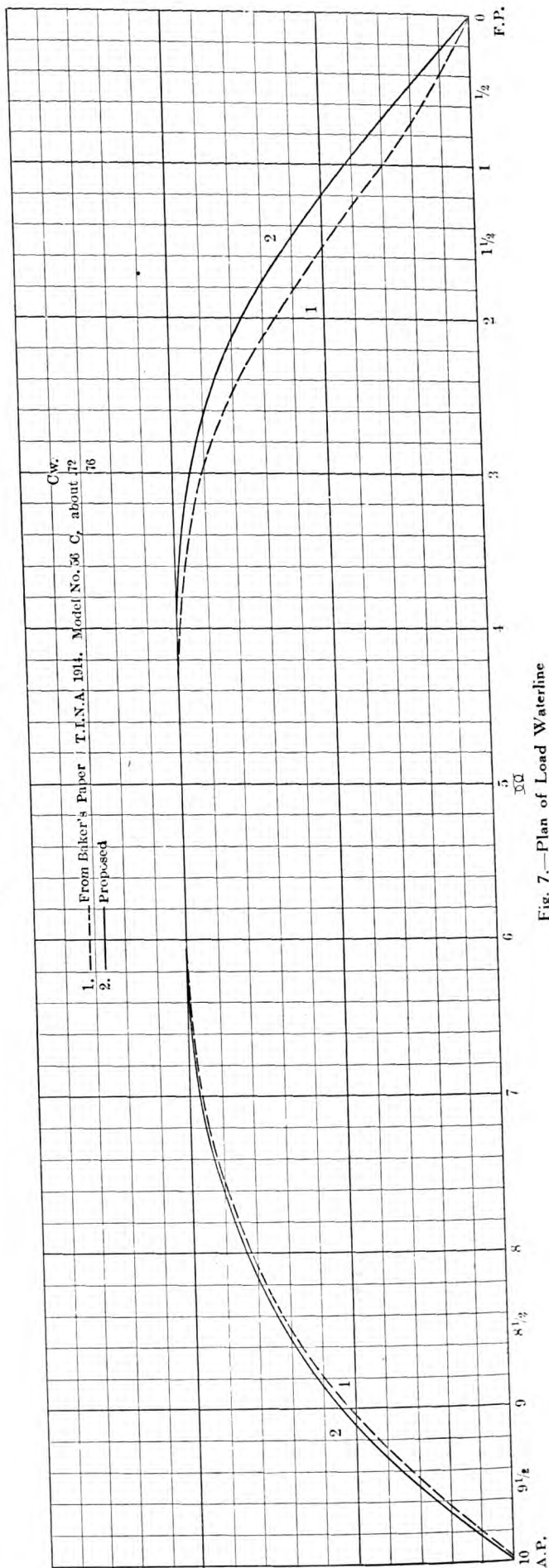


Fig. 7.—Plan of Load Waterline

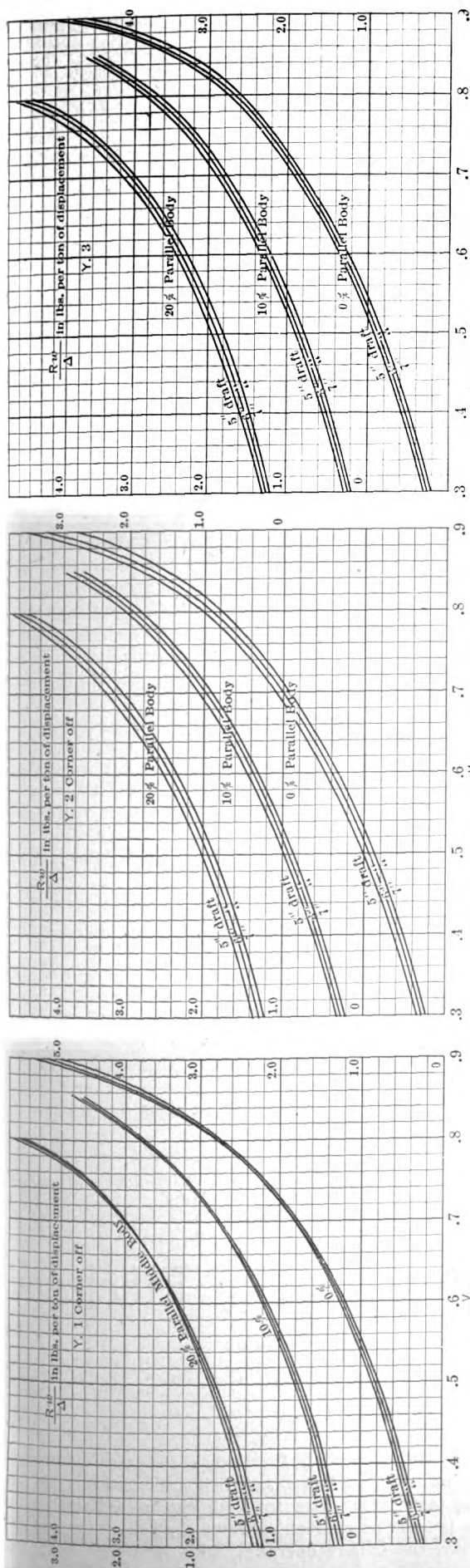


Fig. 8

Fig. 9

Fig. 10

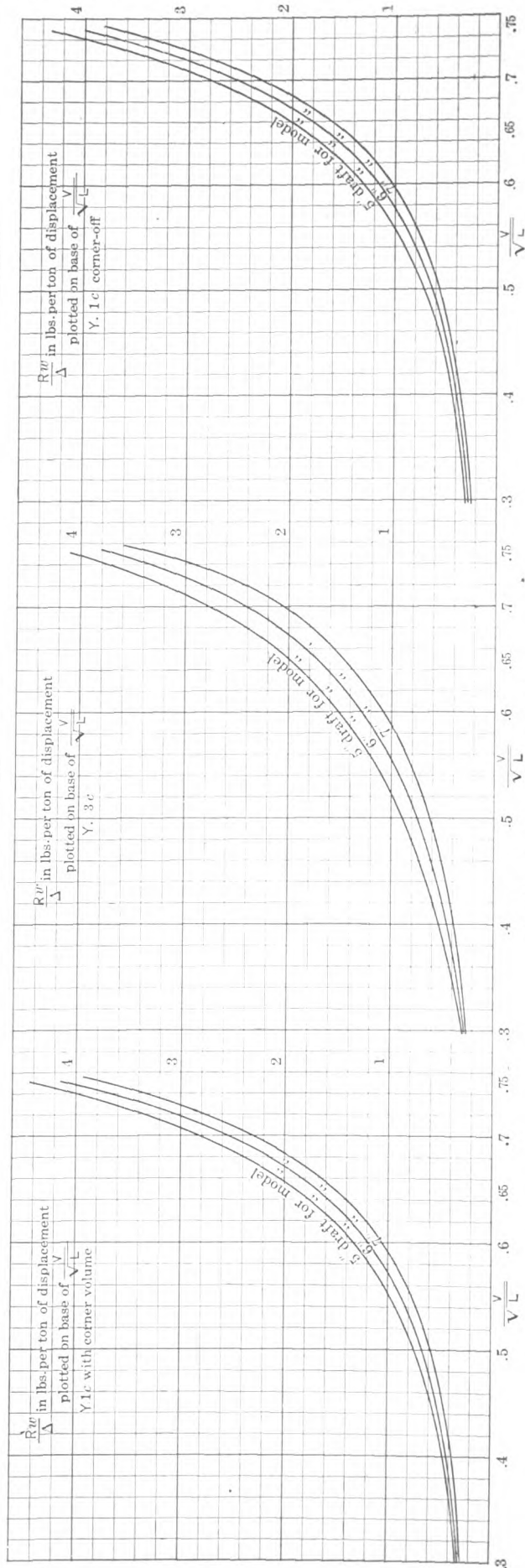


Fig. 11.—Results of Tests in Series 2

Y. 1 (WITH CORNER VOLUME)

Draft, I	/d		0 Percent	10 Percent	20 Percent
7	2.285	Long. coeff.....	.673	.706	.737
		Block coeff.....	.660	.693	.724
		Mid. coeff.....	.983	.983	.983
		Waterline coeff.....	.760	.784	.808
6	2.66	Long. coeff.....	.661	.696	.728
		Block coeff.....	.647	.682	.713
		Mid. coeff.....	.979	.979	.979
5	3.2	Long. coeff.....	.644	.679	.712
		Block coeff.....	.628	.662	.694
		Mid. coeff.....	.975	.975	.975

in all cases to increase the resistance, i.e., the resistance increases at a somewhat more rapid ratio than the added wetted surface. The remaining form with the lower knuckle line dropped (Fig. 1a) shows slightly more resistance than the best of the other forms, but the amount is small; in fact, it seems to lie between the first two forms.

A similar set of tests was carried out upon a model of fuller form. In this case the curve of sectional areas was changed to one suitable for this type. The body plans are shown in Figs. 4 and 5. The particulars of the models are given in the following table:

Y. 2 (WITH CORNER VOLUME)

7	2.285	Long. coeff.....	.672	.706	.737
		Block coeff.....	.659	.694	.724
		Mid. coeff.....	.983	.983	.983
		Waterline coeff.....	.760	.784	.808
6	2.66	Long. coeff.....	.660	.695	.728
		Block coeff.....	.646	.680	.713
		Mid. coeff.....	.979	.979	.979
5	3.2	Long. coeff.....	.646	.679	.716
		Block coeff.....	.630	.662	.698
		Mid. coeff.....	.975	.975	.975

Draft B/d		Y. I. C. Corner off	Y. 3. C.	Y. I. C. with Corner Volume.
7" 2.285	Coeff.....			
	Long. coeff....	.801	.798	.801
	Block coeff....	.779	.779	.785
	Midship coeff	.973	.976	.981
6' 2.66	Long. coeff....	.791	.788	.791
	Block coeff....	.766	.766	.773
	Midship coeff	.968	.972	.978
5" 3.2	Long. coeff....	.780	.778	.780
	Block coeff....	.749	.750	.759
	Midship coeff	.961	.965	.974

Y. C.

7	2.285	Long. coeff.....	.674		.738
		Block coeff.....	.656		.718
		Mid. coeff.....	.984		.984
		Waterline coeff.....	.760		.808
6	2.66	Long. coeff.....	.661		.729
		Block coeff.....	.641		.706
		Mid. coeff.....	.969		.969
5	3.2	Long. coeff.....	.644		.715
		Block coeff.....	.620		.688
		Mid. coeff.....	.963		.963

The fuller models, marked 10 percent and 20 percent, were obtained from the finer forms by adding 10 percent and 20 percent middle body and contracting the form of the ends to keep the length constant.

The curves of sectional areas and load waterline are shown in Figs. 6 and 7, and in connection with the latter it will be noticed that, in order to use the same form in all cases, this necessitated a somewhat fuller line forward than was compatible with ease of propulsion. For purely comparative purposes it was deemed advisable to keep the same waterline throughout.

The general results are summarized in the curves, Figs. 8, 9 and 10. A comparison of each set of curves for each type shows that the shipshape is the best, and that, of the other two forms with the corner off, the one with the steeper slope to the bilge diagonal gives better results than where this is at a smaller angle.

At the lower speed-length ratios there is little, if any, difference, and such as there is, is of the order of 1 to 2 percent. The effect of retaining the sharp corner appears

The results of the tests, shown in Fig. 11, in general are of the same character as in the previous series. The effect of retaining the corner volume at the bilge is to increase the resistance about 3 to 4 percent, or approximately the same as that due to the added surface. Compared with the shipshape form, there is practically no difference in resistance between this and the simplified form with the corner cut off.

Although time did not permit of carrying out a complete set of rolling experiments, some of the models were tried and it was found that the effect of the sharp corner upon the reduction of rolls was most marked, and that even with the corner removed these models came to rest quicker than the shipshape form.

The general conclusions that may be drawn are as follows:

1. Vessels of the straight frame type can be designed which will have about the same resistance as a shipshape form.
2. If the diagonal line of the corner be given the wrong slope, this will increase the resistance due to the lack of conformity with the proper stream line flow.
3. The effect of maintaining the square corner is to increase the bare hull resistance, but as vessels of this form would not need bilge keels the net result from a horsepower standpoint would be about the same as for a shipshape form.
4. Probably the best results from a resistance standpoint would be obtained by using diagonal line which is of a curved form in the body plan.

Fuel Saved by Increasing Boiler Efficiency

Effect on the Fuel Economy and Cruising Radius of Ships Due to Increasing the Efficiency of Boilers

BY LIEUT. W. D. CANAN, U. S. N. R. F.*

THE large saving in fuel, which can be effected by a comparatively small increase in the efficiency of the boiler is not generally realized. This is very strikingly shown in Plate I. Assume, for example, the case of a ship using coal of 14,000 British thermal units, and that the total water rate for both engines and auxiliaries is 15 pounds of equivalent water per indicated horsepower-hour, the boilers operating with an overall efficiency of

ingly shown in Plate I. Assume, for example, the case of a ship using coal of 14,000 British thermal units, and that the total water rate for both engines and auxiliaries is 15 pounds of equivalent water per indicated horsepower-hour, the boilers operating with an overall efficiency of

* Head of Boiler Department, United States Navy Steam Engineering School, Stevens Institute of Technology, Hoboken, N. J.

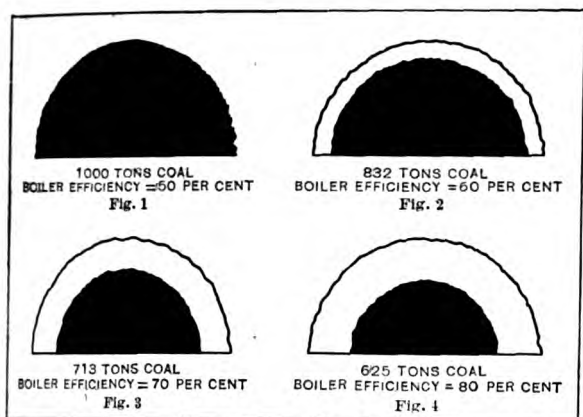


Plate I.—Coal Saved Due to Increased Boiler Efficiency. Heating Value of Coal, 14,000 B. T. U., 15 Pounds Equivalent Water Per Indicated Horsepower-Hour

50 percent. Suppose that, for a given distance steamed, the ship used 1,000 tons of coal, and during this time maintained the water rate of 15 pounds constant. The coal used is represented by Fig. 1. If, now, the efficiency of the boiler had been 60 percent instead of 50 percent, other conditions remaining constant, the amount of coal used would have been 832 tons, or a reduction of 16.8 percent. Fig. 2 shows graphically in the unshaded portion the saving of the fuel due to the increased boiler efficiency.

Figs. 3 and 4 show the saving produced by increasing the boiler efficiency to 70 percent and 80 percent respectively. For 70 percent, the saving is 28.7 percent, and for 80 percent the saving is 37.5 percent of the amount of fuel used when the boilers are operated at only 50 percent efficiency. This saving will be practically the same for various water rates and heating values of the coal, and is approximately the same for both coal and oil.

The increase in the cruising radius or, what amounts to the same thing, the total number of hours the vessel can steam at a given rate is shown in Plate II. These curves show the steaming hours per 1,000 indicated horsepower per 1,000 tons of coal for various equivalent water rates and heating values of the coal. For example, if the water rate of a vessel is found to be 21 pounds of equivalent water, and the coal has a heating value of 13,600 British thermal units, for each 1,000 tons of this coal and for each 1,000 indicated horsepower expended at this water rate, the vessel can steam for 747 hours, the boilers operating at an efficiency of 50 percent. However, if the boilers were operating at an efficiency of 60 percent instead of 50 percent, the steaming hours would be increased to 895, an increase of 20 percent; at a boiler efficiency of 70 percent, therefore (other conditions remaining the same as above), the steaming hours would be 1,045, an increase of 40 percent. For horsepower other than 1,000 and for amounts of coal other than 1,000 tons, the steaming hours are directly proportional.

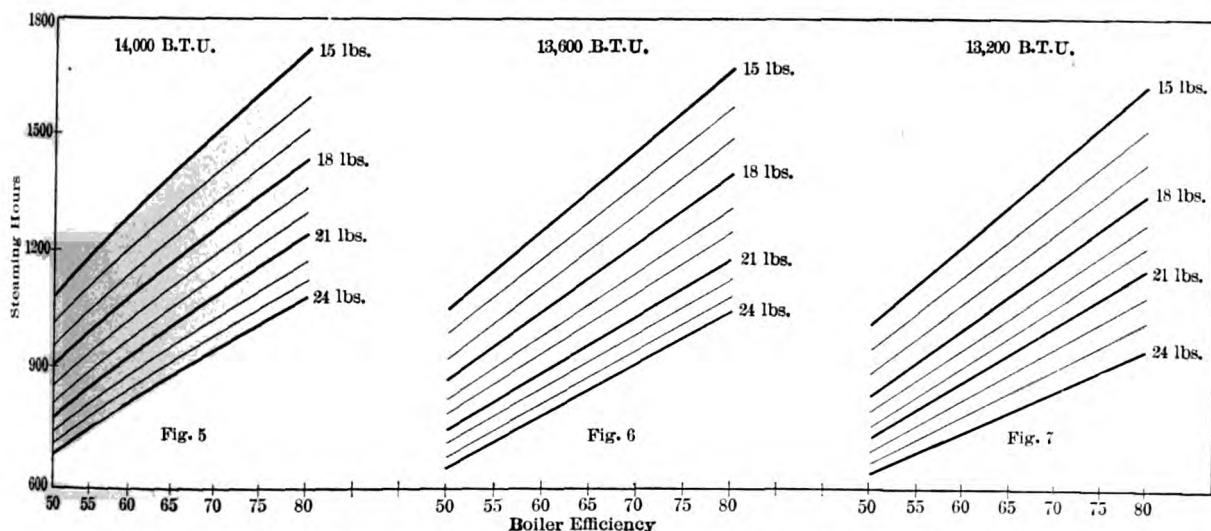


Plate II.—Steaming Hours Per 1,000 Indicated Horsepower Per 1,000 Tons Coal for Various Equivalent Water Rates

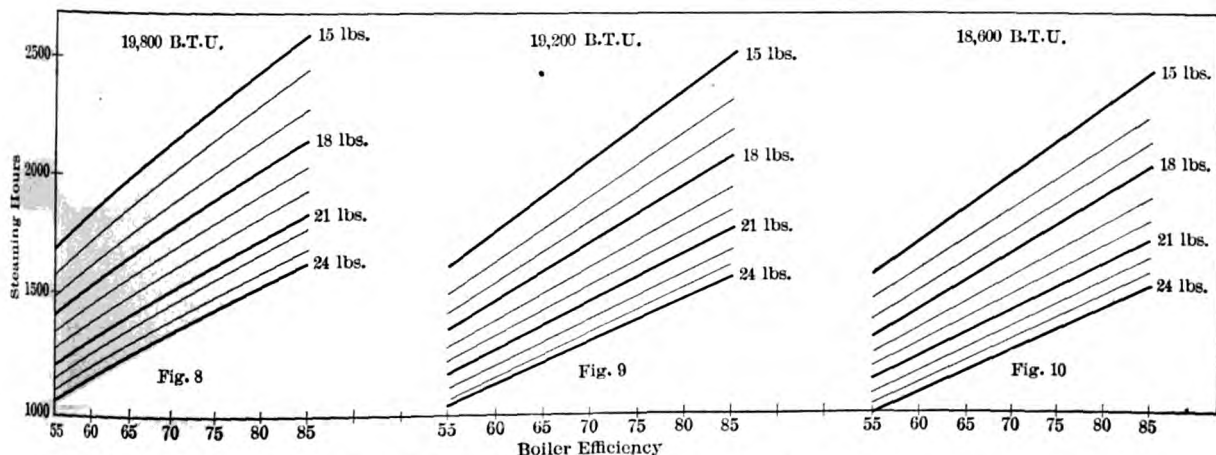


Plate III.—Steaming Hours Per 1,000 Indicated Horsepower Per 1,000 Tons Oil for Various Equivalent Water Rates

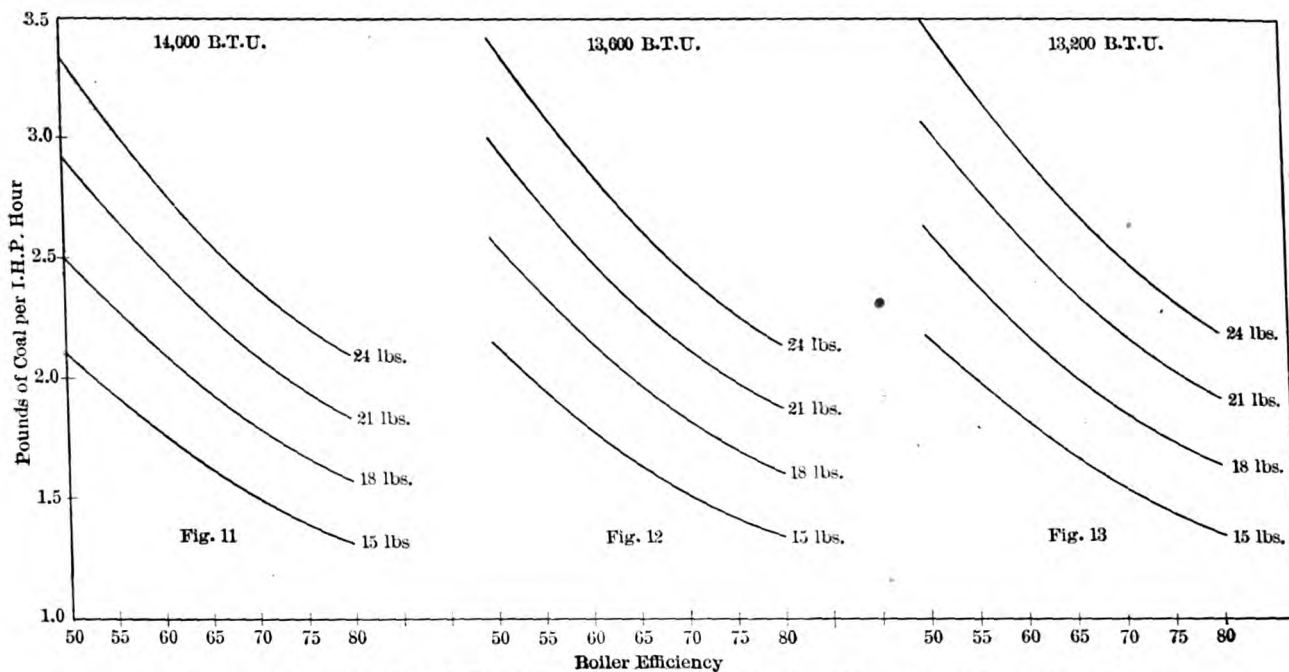


Plate IV.—Pounds of Coal Per Indicated Horsepower-Hour for Various Equivalent Water Rates

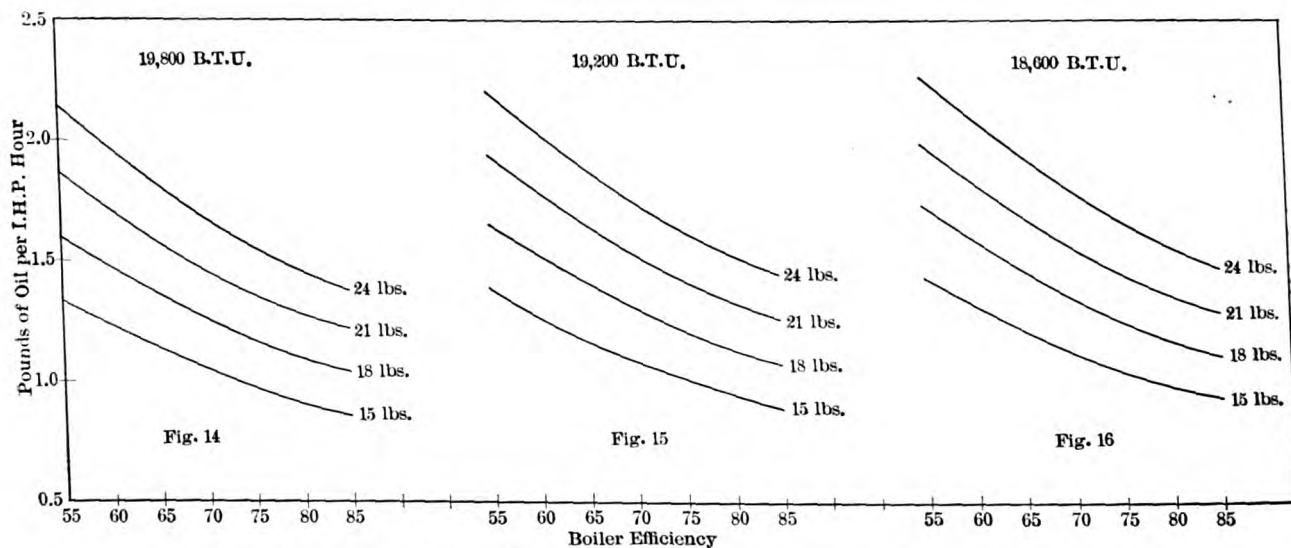


Plate V.—Pounds of Oil Per Indicated Horsepower-Hour for Various Equivalent Water Rates

Plate III shows curves to those of Plate II, but with oil as fuel instead of coal.

Plate IV shows the effect on the coal per indicated horsepower-hour for various water rates due to increasing the boiler efficiency. That is, for coal with a heating value of 14,000 British thermal units and a water rate of 18 pounds of equivalent water, the coal per indicated horsepower-hour for 50 percent boiler efficiency is 2.48 pounds. If the boiler efficiency is increased to 60 percent, the coal is decreased to 2.08 pounds, and for 70 percent boiler efficiency the coal rate drops to 1.78 pounds. Plate IV shows similar curves for oil.

By means of the foregoing curves an attempt has been made to show the marked economy which may result, due to even a comparatively small improvement in the operation of the boilers. Now that the United States has definitely decided to take her place as one of the leading ocean carriers, she will be brought into competition with other countries which can supply cheaper labor to man the ships. If we hope to compete successfully, that is,

carry cargoes cheaper than our competitors, our operating costs must be less than theirs. Since our labor costs will certainly not be less, it remains for us to better our maintenance and fuel costs.

So far as the engines are concerned, not much greater economy than has already been obtained can be expected in the near future. The boiler, fortunately, still permits of considerable improvement, and it is to this important piece of apparatus that we must look for any material decrease in the operating expenses.

Correction

In the article, entitled "German Camouflaging," which appeared on page 103 of the February issue of MARINE ENGINEERING, it should have been stated that the method of disguise was tried out by United States Government experts on captured German ships instead of by Germans on their own ships as printed, owing to a misunderstanding in editing the data presented.

Marine Boiler Standardization

BY C. A. SELEY

THE tremendous programme of the United States Shipping Board in its shipbuilding activities has developed latent powers in production of boilers in this great country of ours. One would hardly think of going to Battle Creek, Mich., Chattanooga, Tenn., Springfield, Ill., or any one of a score or more of inland towns for marine boilers, yet it has been done and the boilers have been produced.

These boilers are for ships in the proposed merchant marine, for which the Scotch type of boiler has heretofore had preference. Our country, however, had not developed Scotch boiler building facilities to the extent to meet the quick requirements for thousands of boiler horsepower, and the Emergency Fleet Corporation was compelled to design a type of boiler that could be built by inland shop facilities and shipped on standard freight cars to the seaboard to supplement the work of shops more advantageously located as to water shipping facilities.

This article is not to enter into the details of this production, but to note the fact and to call attention to the influence of this great lot of boilers on the marine boiler engineering of the future. It is certainly an impressive lesson on standardization and its advantages in large production and installation. In addition there are those lessons of the future in operation and maintenance to be learned.

REASONS FOR STANDARDIZATION

Many hundreds of boilers are similar in details that may need renewals, and there is the double advantage of similarity of parts and of tools and appliances to make repairs. It also greatly simplifies the operating problem in the methods of instruction and acquaintance of the men handling and responsible for steam production to have similarity of equipment and not find a new type or variation on every ship, especially as there are to be "ships, ships and more ships," as the slogan has called for. This all seems even more emphasized by the recent statement of intention on the part of the Shipping Board to effect a world organization to forward the work of administering this country's shipping facilities, which, for the thousands needed to replenish and complete the number of ships necessary will require several thousands of marine boilers.

ADVANTAGES AND DISADVANTAGES OF SCOTCH BOILERS

Adverting to types, the Scotch boiler has certain advantages. Its best, perhaps, is that of long acquaintance. It is accessible for inspection and repair, is integral and self-contained and in a way more fool-proof. Owing to the bulk of water contained, it is less sensitive in maintaining the water level, and particularly so as to effect of salt in the feed-water, if in any amount. It is analogous to the return tubular type of boiler used in land stationary practice, now generally displaced by the watertube type in large plants, where economy of space and costs of operation are ruling factors. It is possible that the same logic of events that has changed land practice in boiler engineering may, as it already has in our navy practice, affect that for the merchant marine.

The marked disadvantages of the Scotch type of boiler are weight and cost per boiler horsepower as compared with those of the watertube type, amounting to ratios between two and three times as against the Scotch. The weight affects displacement and cargo space, the lower efficiency affects coal costs and space. They must be built adjacent to water transportation and handling facilities. Shops must be equipped with special tools and

facilities not required for other classes of boiler work. Conservation of steel has been a great need during the war and is still with us and is an important consideration in boiler design.

CAUSE OF LOWER EFFICIENCY

Lower efficiency has been mentioned—and the reason is simple. The design of the Scotch boiler does not lend itself well to air admission. This is proven by the amount of smoke from such boilers, denoting incomplete combustion in the furnaces, due to lack or improper admixture of air. Combustion is a chemical process and a proper proportion of air is as essential as to a human being. The so-called combustion chambers are not of much aid in combustion except in the case of long-flaming fuel. We are told that there is no radiation from gases beyond the flaming stage, and on this theory the furnaces of locomotive type boilers have been given greatly increased volume and surfaces more fully to utilize the radiant heat and heat of conduction; and the combustion must be complete before passing into the tubes, as the flame will not pass into small tubes, and their value as heating surface is to extract the heat by convection or contact as the gases pass through them. This is the reason for the great number and small size of boiler tubes, so as to gain a great amount of surface for contact of gases. It is well known that a square foot of heating surface in the furnace is many times more efficient than in the tubes, and that is because the furnace gases are not only hotter, but radiate and conduct heat, whereas, the same gases when they reach the tubes can only heat by contact.

Combustion chambers have been added to locomotive boilers to increase the volume for combustion and additional heating surface to utilize resulting heat in such boilers. These, however, are an extension or part of the furnace permitting a more complete mixture of air and gases and to aid more fully in their combustion at the high rate common in locomotive service.

COMBUSTION IN THE SCOTCH BOILER

In Scotch boilers, however, the air admixture and combustion are probably as fully completed as they will be while in the furnace and the function of the chambers is mainly as a passage for the gases from the furnaces to the tubes, absorbing some heat, it is true, though mainly from convection or contact and not to the extent ordinarily supposed. If the area of cross section is sufficient to pass the gases, an increase is not of the proportional value as is the heating surface, which has the benefit of radiant and conducted heat.

It is not at all likely that Scotch boilers will lose favor with many engineers, but will continue to be built for many ships, and for this reason it is believed that some features of standardization and conservation may be timely. In many designs the water-ways at the back and sides of the combustion chambers are made tapering, for which there seems to be no good reason, and in fact a waste of the sheet material, time in laying out and no opportunity for standardized staybolts.

It is assumed that the main reason for the taper is the theory that it assists in water circulation, but it is very doubtful if such is actually the case. As has been pointed out, the combustion chamber walls are not very active heating surface and the water circulation is very sluggish as compared with that in the water legs of a locomotive type boiler of which we have some data as to rate.

CIRCULATION IN A LOCOMOTIVE BOILER

Some years ago, during some locomotive boiler tests on boilers having 58 square feet of grate surface 9 feet

1¾ inches long by 6 feet 4¼ inches wide, carrying 200-220 pounds steam pressure and working to high capacity, it was found that the movement of the mass of water was comparatively slow, being broken by violent local agitations and cross-currents. The average velocity, as noted in a large number of tests, was about one foot per second, with a maximum of not over two feet. The velocity of the steam bubbles through the water was found to be in line with that of free air bubbles rising in water which can be observed independent of boiler operation, but in these tests averaged about 12 feet per second. As the water spaces in this case were less than those usually found in Scotch boilers and the rates of service were approximately 1,000 horsepower, it is believed that the circulation of the mass of water greatly exceeded any possibility in Scotch boiler water-ways and there must have been a vastly greater amount of steam bubbles to accommodate.

Making water-ways straight in Scotch boilers saves time in layout and loss of material in shaping the combustion chamber side sheets, at once a simplification and conservation. It will also simplify the staybolting, as with tapered water courses the length of each row increases from the bottom row upward, making as many lengths as there are rows in many cases.

STANDARDIZATION OF STAYBOLTS

Many shops accept these conditions on the theory that there is a certain amount of variation in assembly of the boiler parts, and some amount of variation is essential in the staybolts, and in fact easiest to meet in that way. The thousands of staybolts in watertube marine boilers, all of one set of dimensions and lengths, are an example of standardization that at least might suggest some economies in that line in Scotch boiler practice. Indeed one very large shop on the Pacific coast has standardized such bolts, making them complete, threaded and tell-tale hole drilled, ready for application, arranged in bins in ¼-inch variables as to length to meet assembly variations which cannot be readily overcome. These are mainly due to sheet buckling, following the flanging of back heads of the boiler and of the combustion chambers. The total range, however, need not exceed 1 inch, and ¼-inch variations call for only five lengths instead of sixteen or more with tapered water course at the back.

At the sides of combustion chambers there need not be as much variation as at the back, if good work and care in the assembly of the parts are insisted upon. There seems to be no good reason for taper of the side water-ways, as it does not seem materially to assist in tube arrangement nor in circulation. Some designs were noted wherein the centers for striking the sides of combustion chambers were so located as to make the water-ways closer at the top corners than on the horizontal centerline, directly contrary to the circulation theory. Some designs locate the shell seams so that staybolts have to pass through butt-straps, which, if avoided, lessens complication and cost and gives the staybolts a better chance in standardization and service and does not impede circulation.

IRON VERSUS STEEL STAYBOLTS

The drilling of tell-tale holes in the outer ends of staybolts, after application, is a difficult and expensive operation and is entirely overcome by the use of standardized bolts. It is, of course, necessary to apply such bolts with a stud nut or driver, which has been very successfully adopted, instead of using a projecting square, which has to be cut off and wasted.

The use of steel for staybolts in marine boilers is ques-

tionable, as it is not borne out in locomotive boiler practice. There is not a locomotive running in this country using steel for staybolts. It has been tried with dead soft and with alloy steels of best quality, as would be imagined from laboratory tests, but did not long survive in service. This is no doubt due to the respective structures of iron and steel. Staybolt iron is built up and has not only slag layers between the sections but in the sections themselves, interposing walls against the progress of a fracture originating in the outer fibers and interrupting the progress of the fracture. Steel is homogeneous in structure, without these slag walls, and a check once started is liable to traverse the whole section. Under these conditions steel staybolts in locomotives were found to break in bunches, so to speak, instead of here and there, and therein lay the danger in their use.

A staybolt with smooth body between sheets has several advantages. It is a conservation of material and time in manufacture and in application and reduces boiler weight without loss of efficiency. It does not offer as good a lodging place for scale as a fully threaded bolt and facilitates washing-out.

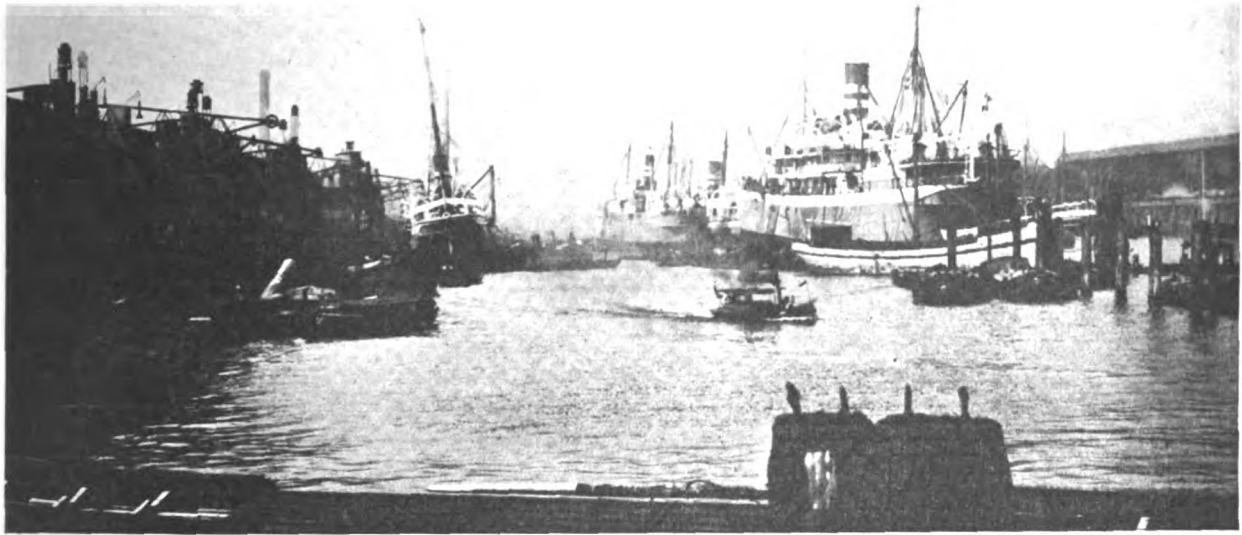
The rules of the Inspecting Bureau permit upsetting of boiler stays which would include staybolts and in the case of steel there seems to be no objection on the score of the structure to obtain a smooth body. With iron, however, the case is different, and upsetting drives back and interrupts the continuity of the structure as originally built and found desirable to withstand the stresses to which staybolts are peculiarly subjected. A smooth body can be obtained by forging down or rolling the body, maintaining the structure, conserving material and other advantages. This is believed better practice than threading bolts full length or threading and then turning off the threads between sheets. These practices waste time and material and give a surface not so good as the skin of the iron removed.

TYPE OF THREAD DESIRABLE

While a fair fit of the staybolt threads in the sheets is desirable, it is believed that such tight fit as to require heavy wrenching is bad practice. It is manifestly impossible to make straight threads steam-tight, and as the threads are relatively fine, heavy wrenching often tears them and subsequent heading up does not fill them out and secure the close contact and fit of threads essential to continued tightness of the staybolts. Good threads on bolt and in sheets, maintained in application by light wrench fits and proper heading over, will give desired results.

Standardization should also be extended to the threads of stays and boiler fittings. The sharp V thread quite extensively used in boiler practice provides sharp corners at the bottom of threads that invite fracture. Engineering practice has learned to abhor a sharp corner as an incipient break, and in the case of threads to use the Whitworth with rounded tops and bottoms, or the U. S. Standard, with flat tops and bottoms. Either of these contributes much in maintaining good threads in application, as the sharp V threads are more liable to catch and tear.

There are many other points, both in design and in shop practice, in which standardization would be of advantage in Scotch boiler production, and in view of the large questions that a growing merchant marine brings up there is an opportunity for getting together the best minds of the marine engineers and naval architects on this important branch of boiler engineering.



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Shipping Tied Up in Hamburg Harbor

Marine Terminals and Foreign Commerce

Adequate Harbor Facilities Will Reduce American Operating Costs One-Third — Larger Berths for New Cargo Vessels — Improvements Planned by British Empire — Germany's Ship Subsidies

BY H. MC L. HARDING*

WITH peace upon us and the resumption of normal conditions of trade and commerce already under way, the United States has as yet failed to work out any specific plans for taking up world commerce along economical lines. The war emergencies made it necessary to enlarge factories far beyond pre-war capacity. Machinery of the latest type has been installed to make possible high speed production. We have the manufacturing means with us. Raw material has always been available in this country. The factor which we still lack is adequate development of foreign trade to market these products. If the United States is to secure complete employment of her available skilled labor she must provide the means to market all surplus abroad.

ENGLAND BUILDING COLONIAL TERMINALS TO ACCOMMODATE LARGE CARGO VESSELS

The situation has been clearly realized by Great Britain; even during the war she has been "getting ready." As an example of far-sighted planning the questions which were sent out by the British Admiralty through the British Royal Dominions Harbor Commission may be cited:

"Are there available berths at your port for ships having a length of 1,000 feet, a beam of 100 feet and a draft of 40 feet? If the provision does not exist for such freight carrying ships, what will it cost to provide such berths? How long will it take to construct or to extend

the piers or quays to accommodate 1,000-foot ships of the above draft and beam?"

Great Britain realizes that she has always excelled in the design of ships. These had been planned and trimmed to afford the most economical utilization for transportation. She now ventures into what has been a field of German supremacy, namely, very highly developed harbor and terminal equipment, as the above questionnaire illustrates.

The following returns illustrate the co-operation of the British colonies throughout the world.

Adelaide, Australia, reported that she would be able to construct four berths of 1,000 feet in length, 41 to 45 feet depth, for \$6,150,000 (£1,300,000). Brisbane promised to spend \$7,500,000 (£1,580,000) for port expansion purposes. Melbourne reported that she would have berths of 1,000-foot length, 43-foot draft and 100-foot beam, for which she expected to spend about \$350,000 (£73,700). Sydney expected to spend \$3,250,000 (£685,000) for a number of larger berths.

Canadian facilities were summarized as follows: Montreal had a 35-foot draft depth available, with long quays; Quebec had a possible 35 to 40-foot depth; Vancouver had a 43-foot depth; Victoria, a 40-foot draft.

Cape Town, South Africa, proposed to expend \$15,000,000 (£3,160,000) to qualify according to specifications; Hongkong, with an expenditure of \$275,000 (£58,000); Aden, with an expenditure of \$4,000,000 (£842,500); Colombo, with an expenditure of \$950,000

* Consulting terminal engineer of the Mississippi River Improvement Association.



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General View of Kiel Harbor, Showing Terminal Facilities

(£200,000), and Singapore, with an expenditure of \$18,886,000 (£4,000,000). All expected to conform to British specifications. Other shipping ports throughout the world sent reports and promises which outline the thought entering into this post-war trade commerce.

The formulation of this plan for terminal enlargement throughout British colonies and the actual answers received show the well developed policy of scientific and co-ordinated improvement which is on foot throughout the British dominions.

England is also instigating improvements at home. At the port of London, for example, improvements are in progress which will afford a channel up the Royal Albert dock with a minimum depth of about 46 feet. A new dock under construction will have a quayage of nearly two and a half miles. At Liverpool also the new Gladstone dock is now 1,070 feet long; the total improved quayage of the port, including Birkenhead, when completed will be over 37 miles.

THE 1,000-FOOT SHIP ECONOMIC OPERATING UNIT

Because of the dire emergency, it was not possible for the United States, in her programme, to consider vessels of the most economical type. The available ways and those which could be quickly constructed made it seem advisable to build many 5,000-ton ships. Recent figures tend to show that vessels of 7,500, 8,600 or 9,000 tons are more economical to operate in the matter of crews, fuel consumption and other operating costs.

It is a well known fact that the larger the ship and the greater the tonnage carried, the less are the transporta-

tion or carriage costs. One of the coastwise shipping companies of the United States a number of years ago found that by increasing the carrying capacity of its ships from three thousand to five thousand tons no increase in operating expenses resulted. Accordingly the smaller ships were sold and replaced by the larger ones.

It may be assumed that the 1,000-foot ships will probably have a net carrying capacity of more than 40,000 tons. Cargoes, therefore, when there is ample freight, can be carried at much less expense in one large ship of 40,000 tons capacity than in four ships each of 10,000 tons capacity, since many of the fixed charges are the same in either case. The influence of such large ships in the securing of foreign commerce should receive full consideration.

As yet we have not formulated definite plans for the operation of the huge fleet which is now under American register or building. Such decision, of course, rests with the Administration. The improvement of harbor facilities, however, which is quite as vital for economic operation, can be taken up by the special cities. The increase in operating expenses which may result from the use of the type of vessels available must be balanced by the cheapened operating costs which improved harbor facilities will provide. Those cities which expect to handle the trade should begin work on harbor improvements at once.

MEANS FOR REDUCING AMERICAN OPERATING COSTS ONE-THIRD

That by correctly designed terminals the time of transferring and handling cargoes in the United States can be

reduced to at least one-third or less the time consumed today is the opinion of competent harbor engineers. San Francisco is alive to the fact that by improvements along this line she will be able to compete with other Pacific ports which are nearer in mile distance to Oriental markets. Commercial cities on our Atlantic seacoast should be "up and doing" along the same lines. This estimation of the reduction of the time which ships lay at the port for unloading may practically be considered a fact. Hence facility for unloading a given tonnage in one-third the time that it takes to complete the work with our present facilities would go a long distance toward reducing high operating costs on shipboard. The initial cost of additional quay construction is, of course, a factor which cannot be obviated. Unfortunately this nation has delayed too long in its construction of adequate up-to-date ships. The retrieval may be well accomplished by bringing our terminal facilities above foreign standards.

IMPROVED AMERICAN HARBOR FACILITIES NECESSARY TO COMPETE WITH GERMANY

Little is known, as yet, of the new commercial schemes which will be launched with the German commercial fleet. When that nation recuperates they will, doubtless, build larger ships along the lines which were already far advanced when the war broke out. She will also further improve terminal facilities.

Before the war, German terminal costs were about one-third smaller than in the United States. When we are cognizant of the means which will reduce this handicap—harbor improvements—work should be begun at once. Germany has also always had the advantage of excellent co-ordination between rail and ship. This fact is plainly evident from a personal study of the ports and their methods of operation. The utilization of inland rivers and canals, with low railway rates for routing export freight to the seaboard, has been a factor in Germany's struggle with competing nations.

This nation has also relied upon what has been termed "economic penetration," to increase her commercial "fighting" ships—the silent art of obtaining control of American and European steamship companies' lines to further trade possibilities. It is stated that even now, through neutral shipping companies which are secretly controlled by the Germans, substantial interests are being purchased in other neutral shipping companies. The system has many ramifications. Purchases which were made early in the year 1918 may come under this category. It will, of course, be easier to buy small holdings later, so as to obtain controlling interest of these companies, than to purchase fifty-one percent outright at one time. This method of obtaining control of shipping facilities is possible without a great cash expenditure.

Another feature of German operation which bears upon the American problem is the report that as far back as 1917 the Reichstag of Germany was arranging to pay war losses to German shipowners by state subsidy. It was stated that some \$500,000,000 (£100,000,000) would be authorized for this purpose. It was also rumored that a proportional greater subsidy was being offered for ships built under war conditions. These subsidies were for cargo carriers. One hundred and fifty thousand tons, it is reported, have already been ordered, at the cost of \$90,000,000 (£18,000,000) (500,000,000 marks), with the present value of 18 cents as a basis.

Neutral countries are not to be left behind in developments. Swedish and Norwegian ship companies are being organized, and harbor facilities are being enlarged in these northern parts. France also hopes, with her colo-

nies, and the Dutch, with their East Indian possessions, to increase trade facilities throughout the country.

It is evident from the above data and other available material along these lines that foreign nations are leaving no stone unturned which will aid toward increasing their present possibilities for trade.

The "coming in" of the 1,000-foot steamship carrier which is of 40-foot draft and 100-foot beam, and has a cargo capacity of about 2,000,000 cubic feet, will require sheds at least 800 feet long, 80 feet wide, and a clear height of 35 feet below the trusses. The nation must be ready to handle trade from these boats as well as the cargoes of her own floating equipment.

Piers, sheds and warehouses must be developed to meet these new conditions. Few port terminals, ocean or inland, are correctly equipped in the United States at the present time. Ships without good terminals are like railways without freight stations. It behooves engineers of this country to develop our facilities along the most modern lines. If the United States is to secure its share of the foreign trade, it must take every means in its power to compete on equal terms.

The Personnel of the United States Merchant Marine

BY A MARINE ENGINEER

ONE of the most important problems before the United States is the question of cost versus competition, of the personnel of the United States merchant marine. Our laws are now such that compensation for men who go down to the sea is said to be prohibitively high.

Many years ago, the writer had an experience which was duplicated in thousands of cases in the United States merchant marine. I served my time at sea in the various subordinate positions and qualified for a license as an engineer. At that time ships were undermanned, and engineers had to put in fourteen to eighteen hours a day to keep their plants up and hold their jobs. A man had to quit his job, if he desired to spend a few days at home. The work on steamships was desperately hard, dangerous and unappreciated. The quarters were poor and the food worse. On one occasion the engineers, by superhuman efforts, kept a ship from foundering in a typhoon. In order to do this they had to cut some of the pump suction pipes. When the ship reached port, the employers, instead of showing appreciation, discharged the engineers because of the damage to the pipes.

This was by no means an individual instance, but typical of the times. Practically all of the better class of engineers sought jobs ashore, and it was this enormous reserve which supplied the marine engineers who carried our troops to Europe. A large majority of the better class of these men are hustling back to their shore positions as fast as they can get their discharges.

The dominating characteristic of human nature is fear—more specifically, fear for the future, fear that one will not have sufficient to live on, fear that one's position is not permanent. Most marine engineers go to sea because they cannot do anything else. The same may be said of ships' officers. There is no class which temperamentally desires to be away from home. American homes are particularly attractive compared to those of other countries. Few sea-going men will admit that they follow the calling for pure love of it, and the better class of engineers invariably leave the sea while still in their twenties, obtaining positions as engineers, mechanics, salesmen, traveling experts, etc.

It does not necessarily require high wages to induce men to go to sea. Why is it that the Civil Service has no trouble in obtaining all the help that it requires at wages considerably lower than the industrial scale? It is because stability, a permanent job, old-age pensions, insurance, etc., are provided. In other words, the Civil Service assures the man that, although his salary is small, he need never worry again about a position nor walk the streets hunting for one. Large corporations, like the Standard Oil, Ford Motor Car Company, United States Steel and others, have practically solved this problem by offering permanence of position.

From these thoughts, the writer ventures to deduce that if a merchant service similar to the navy, but more adapted to merchant needs, be organized, sea-going men can be invited to join this service instead of joining a ship here or there wherever they can get the job and losing the job when the ship is laid up. It could be arranged for men to enlist in this service, as in the navy, and be assured of their pay at all times whether on board ship or not.

The requirements to attract men into such a service would be as follows:

First.—A permanent salary for the time of the enlistment, with the privilege of re-enlistment. This must be a living salary, but not necessarily large. The main requirement is permanence.

Second.—Suitable opportunity for promotion. Ranks could be provided similar to those in the navy.

Third.—Definite ratings and duties.

Fourth.—The high ranks to take the better ships and runs and to have more or less personal choice of duties.

Fifth.—So far as possible the men should be put on steady runs. Under such circumstances they can arrange their lives and domestic affairs with reasonable certainty.

Sixth.—In proportion to merit and seniority the percentage of shore duty shall increase.

Seventh.—Correspondence-educational facilities shall be provided, together with circulating libraries and periodicals.

Eighth.—Suitable port headquarters shall be provided, perhaps in co-operation with one of the great welfare organizations.

Ninth.—Uniforms sufficient for the purpose without unnecessary expense.

Tenth.—Proper provision for cadets and apprentices who are graduates of technical schools or machine shops or both.

That such a system would appeal to marine engineers is the opinion of a man who is one and who knows marine engineers. In the past and at the present time, no marine engineer is at all certain of his next pay day and few are enthusiastic about their profession. The writer realizes that employers have been up against conditions which they could not govern, but he writes solely from the viewpoint of the average marine engineer, because that viewpoint cannot and will not be changed until human nature changes.

Tar Varnish For Iron Work

Heat about 100 gallons of tar to a low boiling point and add 100 pounds of fresh slaked lime sifted over the top and then worked down. Boil this mixture until it becomes pasty. Let it settle for a few minutes and then add 20 pounds of tallow and 5 pounds of powdered resin. Stir until thoroughly mixed and all ingredients dissolved, then allow to cool. The mixture should not be raised to a

higher temperature than 100 degrees F. Should the preparation be too thick, it can be thinned down with paraffin or naphtha.

This gives a finish like stove enamel. All gas holders and galvanized iron roofs and galvanized sides of buildings are painted two coats with this tar varnish and then whitewashed thoroughly, protecting them from the weather and salt air. The varnish is elastic and will stop corrosion.

Lubricating Marine Machinery

BY W. D. FORBES

Lubrication in the machinery of a vessel is as important as the machinery itself. Yet the subject of lubrication, with special reference to marine work, is given but a superficial consideration outside the province of lubrication engineers. To this end I have written a general article covering all the manifest phases of lubrication in marine machinery, and hope that you will give this article space in your columns.

In the lubrication of marine machinery it is well to bear in mind the fact that when vessels are operated on salt water, fresh water must be used in the boilers, and that besides the water required to fill the boilers an extra amount has to be carried in order to make up for a certain amount of loss in the water's cycle of use. The cycle is well known. The water is turned into steam, which passes first to the main and auxiliary engines and then to the condenser, after which it is pumped back to the boiler by means of the feed pumps or injectors.

As is well known, any oil which finds its way into a boiler is detrimental to the boiler, because it fastens itself upon the sheets and tubes and thus prevents the water from coming in contact with the metal surfaces. This results in their burning out, which shortens the life of the boiler and necessitates repairs, besides increasing the danger of an explosion.

Therefore it is evident that internal lubrication of the engines is inadmissible. A certain amount of interior lubrication will result. Stuffing boxes around valve stems and piston rods must be lubricated of course, and these stems and rods will carry a certain amount of oil into the valve chests and cylinders. In order to get rid of this oil, however, grease and oil extractors are placed between the steam discharge of the condenser and the boiler feeds. Other parts of marine engines which require lubrication, aside from the stuffing boxes, embrace the flat surfaces of the guides and gibs, the arced surfaces of the links and blocks, the oscillating surfaces of the wrist pins in the crosshead, the rotating surfaces of the eccentrics and straps, the main bearings, and those of the crank pins and brasses. Besides these there are the rotating shafts of the blowers, electric light plants, circulating pumps, and the like, as well as the bearings supporting the propeller shafts. These last are lubricated by either grease or oil, or, as in the case of the tail shaft, by a combination of water and oil or by water alone, where the shaft passes through the hull of the ship.

Whether grease or oil is used is a matter of choice on the part of the chief engineer of the ship or company. Usually on the main engines the gravity system is employed. In this system cups or oil boxes are provided, or oil cups with copper tubes leading to the bearings. Where tubes are provided the cups are fitted with some means of controlling the flow of oil. Usually, however, the bearings of the main engines and those of the propeller shaft are not fitted with any means for controlling the lubricant. The thrust bearings usually have an oil cup on each horse

shoe. Sometimes a thrust box is provided so that the collars on the thrust shaft dip into the oil there. The oiling of the link box is quite commonly done by means of oil cups in which curled hair is placed; the lubricant is supplied by means of a squirt can. The curled hair prevents the oil from being thrown out. Not infrequently the squirt can is replaced by oil cups and tubes.

Of course this system of oiling needs close watching. The crank pin is lubricated by oil tubes leading down the sides or fronts of the connecting rods. At their upper end these are furnished with elongated oil cups into which drops of oil fall from the oil tubes. This idea is somewhat modified at times by providing a wiper on the crosshead and crank pin oil cups, so adjusted that at the extreme upper position of the stroke a certain amount of oil is wiped from the end of the oil tube. Long spouted oil cups are used to supply fresh oil to the main bearings.

Another style of lubrication, far preferable, is known as the "forced oil system." In this system the lubricant is pumped through oil pipes, under more or less pressure, to all principal bearings. This system, however, demands an enclosed engine—in other words, a case which prevents the oil from spattering about. Such a case collects the oil in a base. Here it is strained, allowed to cool and again returned to the force pump. This system, which has been common on small engines, is now being applied to very large ones as well. There are two ways of meeting the requirements of reaching oscillating or reciprocating parts as well as crank pins. One is to drill into the crank shaft pin. This throws and forces the oil into the rotating shaft to the main bearings and crank pins, up through the connecting rods to the wrist pins, crosshead shoe, guides and gibs. In this system the piston rods and valve stems, as well as the link blocks, rely for lubrication upon the oily atmosphere in the engine case, which is usually quite sufficient. On very high speed engines of small size this system has proved quite satisfactory. It is open to serious objection, however, on the ground that the oil passages are extremely difficult to clean without dismantling the engine. A second system provides piping leading to the main bearings, and by means of telescopic tubular connections to the crosshead pin, thence by tubes to the crank pin bearings. In place of the telescopic connections, a grass hopper swinging joint or joints with pipe connections may be substituted. If this system is properly installed by the removal of certain plugs, steam can be blown through and the tubing thoroughly cleaned with comparative ease. In either system, however, it must be remembered that oil is lazy and unaccommodating, and will always take the easiest way of movement. Therefore, the sizes of the openings leading to the various bearings must be varied in their diameters, so that the oil will be forced to travel to all bearings in sufficient amount to lubricate them properly, otherwise some bearings will be flooded and others will not receive a sufficient amount of lubricant. The easiest way to accomplish this is to place washers with varying sizes of holes in the ends of the tubes. Because of the lack of understanding of this fact, the forced oil system is often reported as "unsatisfactory." It is, of course, necessary to have a good quality of oil in any system. In the gravity system, however, the quality of the lubricant is most important, as it is not so constantly supplied. In the forced system, on the other hand, where a great volume is constantly applied, the quality of the oil need not be so good. In all cases, the oil must be free from grit and foreign substances.

It is a common idea among men in charge of engines that after the valve chests and cylinders are once oiled it is necessary to continue oiling them. This is a fallacy.

In the vertical style of engine, if it is properly made, no friction results on the cylinder walls, save from the pressure of the rings. If the cylinders and rings are well designed and made of proper material, truly machine fitted, this friction is light. By balancing the low pressure slide valves their friction is greatly reduced. In starting up reciprocating engines it is advantageous to introduce plumbago into the steam passages and to run them slowly with low steam pressure. The water in suspension and the plumbago will very soon put a high polish upon the sliding surfaces.

In the modern prime mover, the steam turbine, there are no sliding surfaces. The only things to oil are the main bearings, which in larger units are always done under pressure. These bearings must be carefully watched, as excessive wear would allow the rotor to drop, which in some makes of turbines would result in stripping the blades, causing serious damage.

It is worth while to say in conclusion that, while it is of prime importance to get a lubricant to the bearing, it is of equal importance to determine the point of the bearing at which the oil should enter. In the steam turbine it matters little whether the oil enters directly at the top of the bearing or at its side; in either case the opening should be at the center and not at the ends of the bearings, as oil will invariably work out toward the ends of the bearings, but will not work in toward the center. Where the engine is of the reciprocating type the oil holes should never enter at the top of the bearing but through openings drilled in such fashion as to lead the oil to each side or edge of the bearing. In this class of engine the upward pull of the connecting rod tends to close the oil opening, if placed at the top, just at the moment when lubrication is most needed.

A point often forgotten by engineers, or, more properly, engine builders, is that only one side of the crank pin gets any wear except when the engine is reversed. In laying out the oiling system this fact should be borne in mind. When an enclosed engine is used the very greatest care should be exercised in thoroughly cleaning out the bed so that the oil will not become dirty. Also, it is advisable to paint the interior carefully with several coats of enamel paint—white is the preferable color.

In the use of grease, two systems are employed. In the first, an open box or cup is provided to receive the grease, and the heating of the bearing is relied upon to liquefy the grease so that it will reach the bearing surfaces. In order to facilitate this heating, it is quite common to provide pieces of copper wire which are thrust down through the grease until they rest against the shaft. Since copper is a good conductor of heat, the grease is more quickly liquefied by the heating of these copper pieces. A slight jar or movement of them aids the feeding of the grease and prevents what is sometimes called "caving"—the term used when the grease near the opening to the shaft warms and flows out, leaving a cavity. Quite an amount of extra heat is needed in order to break this down and continue the lubrication.

The second system used with grease is that known as a "compression cup"—automatic or adjustable. A piston is fitted to the cup, and, in the automatic, this piston is forced down into the grease by means of a spring, while in the adjustable type the piston is forced down, from time to time, by a screw passing through the cover or cap. The automatic compression grease cup is advantageously used on the suspension pins of the governor of an electric light engine, as these pins cannot be readily reached by oil tubes. The adjustable cup can be used where it is stationary and can be easily reached.

An Apprenticeship Course for Shipfitters

**Lack of Ship Mechanics Handicaps Shipbuilding—College Courses Needed—
Shop Instruction Should Correlate Trade Knowledge With Shop Practice**

BY W. H. DOOLEY*

THE progressive development of shipbuilding in this country depends upon the technically trained managers, experts, draftsmen, superintendents, foremen, skilled mechanics and helpers, available for the industry. For several generations prior to the war, shipbuilding has been sadly neglected by the American people. The United States Government training schools and a few technical schools, like the Massachusetts Institute of Technology, have been the only educational institutions which encouraged the study of shipbuilding. The experts, managers and draftsmen employed here have either been trained abroad or in one of the college grade schools.

NEED OF SHIPBUILDING EXPERTS

In the past it has been possible for men who lacked technical training, but who possessed good common sense and business capacity, to rise to managership in the shipbuilding industry. This is not true to-day. The manager must be a technically trained man, who enters the industry direct from school. Initiative force, a keen analytical mind, and pronounced executive ability are the requisites.

During the ages, progress in shipbuilding has been due to a few scattered inventors and workmen laboring under great disadvantages. Shipping interests are just beginning to see the possibilities of applying scientific discoveries. Competition with England and other foreign countries compels us to realize that shipbuilding has become a science. Old rule of thumb methods must give way. Continuous employment of scientifically trained supervisors is the answer. They will show up the weaknesses which increase the cost of production; they will improve the design of tools and machines, and completely utilize waste products. To provide these men the college grade institutions must institute courses for training experts in shipbuilding.

THE FOREMEN AND JOB MASTER

The superintendent of a shipbuilding plant usually comes from the ranks of workers. As such he is the job master of all the intricacies of the work. An additional qualification, however, is the ability to get good work out of men. This means that he must judge human values correctly. His outlook on life must be broader and more comprehensive than that of the worker.

THE SKILLED MECHANIC AND HELPERS

The skilled craftsman or mechanic should have, in addition to excellent health, a clear, inventive mind. Like the highly skilled machine shop worker, the skilled shipworker acquires by experience manual dexterity and a fund of information which forms the basis for new judgments. Since the skill of the shipowner depends upon his constant practice of the shipbuilding trade, he cannot leave the work for any length of time without losing dexterity.

Helpers and the semi-skilled workers, so necessary in shipbuilding, also need a strong body and the quick, mental perception which guides manual dexterity.

The lack of properly trained, first-class mechanics in the shipbuilding trades, who are capable of taking positions as superintendents and foremen, is the industry's present handicap. The most effective system of training a first-class mechanic is an apprenticeship to the trade covering at least three or four years. Boys of fifteen or sixteen years of age should be started in the trade under a mechanic. If the boy begins much later, he will probably leave before completing his apprenticeship. Some educators favor sending boys to trade schools until they are eighteen and then allowing them to enter the trade. Such a plan has been worked out in many industrial high schools and co-operative courses, but has failed to produce mechanics who are willing to remain in the productive side of industry. They usually find positions more attractive in the distributive phase as salesmen or buyers of supplies.

Apprenticeship courses may cover shipfitting, shopsmithing, joinery, boatbuilding, plumbing and sailmaking. Similar courses may be established in the machinery division of shipbuilding—machining and die-sinking, copersmithing, boiler making, pattern making, molding and electrical work.

TRAINING THE APPRENTICE

The apprenticeship course should be in charge of an educational supervisor who has complete charge of the training of apprentices. The carefully planned course, which will be outlined later, divides the material to be considered into two heads: shop or trade practice and related trade knowledge. The course in trade practice, which is given in the shop under the direction of a first-class skilled mechanic, should be arranged so that the apprentice may receive thorough shop experience and not be held on any one type of work at the expense of his training in the other lines. This is one of the most difficult pedagogical problems. The shipyard shop in which apprentices are taught is usually laid out to do commercial work and the foreman holds his position on account of his ability to keep up production. Both officials and mechanics are often tempted to keep apprentices on work which they can do to the advantage of the yard. Therefore, in the interest of the proper training of the apprentice it is necessary to keep a record, a card will be found the most practical, showing the time, allotment in hours or months, for each apprentice in the different lines of work practiced in the trade. At the end of each week the officials, including the supervisor of apprentices, should record the time, in hours, which each apprentice has devoted to each kind of work or machine. In this way, it is also possible for the apprentice to know the time spent on each type of work, so that he may see the progress he is making.

During the early period of the course the apprentice should perform the menial and disagreeable parts of the trade which require little training or skill. For at least one-third of the full course the apprentice should be under the guidance of trained men to prepare for the time when he will be thrown upon his own resources. The shop experience should be graded so that the apprentice develops responsibility, accuracy, and care in the operation of expensive machinery.

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One month during the last year of the apprenticeship should be spent in the estimating department to emphasize the need of economical work, as it relates to the cost of labor, time and material. The remainder of the last year should be spent upon working entirely from plans.

RELATED TRADE KNOWLEDGE

The related trade knowledge, as outlined in the course which follows, includes such facts as are necessary for intelligent work,—trade mathematics, trade science (that is, the principles of physics and chemistry which are applicable to the trade), shop sketching, interpretation of blueprints and some trade English.

WORKING PROGRAMME FOR APPRENTICES

The working week should consist of 48 hours; 40 to 44 hours spent in actual shop practice and 4 to 8 hours spent in studying related trade knowledge. This course may be given in a vacant room or loft.

A formal report upon the work of the apprentice should be sent home every six months. This record also should be placed on the apprentice's life card, a permanent record of the school which should be kept by the supervisor of apprentices. In these reports the apprentice should be graded according to the standards of a successful mechanic, under the qualifications: adaptability, speed, ability to do accurate, well finished work, reliability of conduct and punctuality in reporting for work. In addition, a measure of the apprentice's aptitude for the trade might be entered under the characteristics—initiative, tact, analytical ability, enthusiasm, personality and decision. It would also be valuable to have a record of those qualities in which he excels and those in which he is deficient.

CORRELATION OF TRADE INSTRUCTION AND SHOP PRACTICE

Complete correlation of shop trade instruction with shop practice in the various branches is the aim of the course outlined below. The courses in shop English, shop science, shop mathematics and shop drawing in each of the periods into which the complete three years' work of instruction is divided, handle parallel subjects.

For example, while the apprentice, in his shop English course, is having practice in the spelling and description of various tools in the tool room, in his shop science course he is learning the types and manufacturers' names of the tools and their use. Parallel with this is the shop mathematics course, giving practice in solving the simple problems which deal with measurements. These elementary problems, involving addition, subtraction, multiplication, and division, are applied to tools in the tool room. At the same time, in the shop drawing course, the apprentice is gaining practice in making rough pencil sketches of tools, such as chisels, wrenches, hammers, nuts and bolts. Out in the shop during the whole period the apprentice actually handles the tools. He receives them, stows them away, repairs them and issues new tools—all under the direction of an experienced mechanic. All the materials in the stock room, and the hand and power tools, are used for his instruction. The purpose of the whole project is to completely familiarize him with the tools of the shop-fitting trade. A comparison of other parts of the course will show this careful correlation of instruction with shop practice throughout.

A general course in the interpretation of blueprints is first outlined below. The purpose of this course is to teach the apprentice: (1) to understand and work from a drawing or blueprint; (2) to make rough drawings and sketches necessary in the trade; (3) to provide an opportunity during the latter part of the course for advanced or

exceptional students to make complete working drawings. Since the aim of this course is to give a training to apprentices which will increase their efficiency as mechanics, the method of teaching used and the information given must be adapted to meet this aim. It must be remembered that the average apprentice has a very different type of mind from that of the young man who intends to be a draftsman, since a draftsman should have considerable power of abstraction—a mental exercise which the average apprentice does not engage in to any great degree. The regular course in mechanical drawing, therefore, should not be given to the average apprentice with the idea of increasing his shop efficiency. As in the other courses which follow, special developments of the work are handled in periods varying from one to four months.

GENERAL THREE-YEAR COURSE OF STUDY IN INTERPRETATION OF DRAWING

First Year

ONE MONTH.—Short, simple explanations of the purpose of the course and the value of it to an apprentice. Freehand isometric (or perspective) sketch of a rectangular piece of stock or part used in the shop, drawn from copy without dimensions. Sketch of other rectangular parts drawn from copy without dimensions, later with dimensions. Freehand sketch of parts containing curved lines, using rule for measuring only, black stock, nuts, bolts, washers, rivets, screw threads may be used.

FOUR MONTHS.—Lettering. Rough pencil sketches of files, chisels, wrenches, various kinds of hammers, appliances, heating furnaces, shape of stock used. Names of parts of tools marked.

FOUR MONTHS.—Shapes of stock in two views to develop the idea of projection (plan and elevation), also views of stock assembled in two parts.

THREE MONTHS.—Sketches of parts of vessels, boats, stock, engines, motor, dynamos and wiring.

Second Year

ONE MONTH.—Drawings of simple parts of the machines used in the shop, as pulleys, levers, spindles, gears and cutting heads.

THREE MONTHS.—Practice in reading simple blueprints, such as used in the shop: dimension of parts, distance between centers, etc.

ONE MONTH.—Drawings of simple parts of machines used in shop involving two views.

THREE MONTHS.—Geometrical construction applied to practical work in the shop, such as inscribing hexagon or erecting perpendicular, bisecting angles, reproducing angles, dividing of pitch circle or other problems.

ONE MONTH.—Practice in drawing more complicated assembled parts.

THREE MONTHS.—Practice in drawing assembled parts, introducing the idea of simple shapes expanding into irregular surfaces.

Third Year

SIX MONTHS.—Practice in drawing in ink, tracing and making a blueprint. Drawing of two views of parts of machines. Sectional views.

FIVE MONTHS.—Practice in making drawings from data or sketches of parts made in shop, and in showing how they are installed.

ONE MONTH.—Practice in making drawings of complete machines, or parts of ships, or boats, to show knowledge of working mechanism and construction.

THREE-YEAR COURSE OF STUDY IN INTERPRETATION OF BLUEPRINTS FOR SHIPFITTERS

First Year

ONE MONTH.—Practice in making rough pencil sketches of nuts, bolts, rivets, screws, washers, taps—isometric plan and elevation views.

FOUR MONTHS.—Practice in making rough pencil drawings of tools, such as files, chisels, wrenches, various hammers, appliances and metals; heating furnace; oxy-acetylene set; simple plates, rivets in section, angle bars, tee bars, Z-bars, channel beams in two views—to develop the idea of projection. Practice in making drawings to illustrate: rivet spacing, one view of the design should illustrate simple connections, that is, a deck to a bulkhead, bounding bars, in

watertight, non-watertight and oiltight bulkhead spacing; various types of rivets in plates (in section).

FOUR MONTHS.—Pencil drawings of shapes of tees, I's, and channels. Two-view drawings of bulkheads, bracket plates, hatches, manhole doors, watertight and non-watertight gun ports, hammock berthing, etc.

THREE MONTHS.—Drawings of blower foundations; scuttle butt brackets; tank foundations; knee beam connections at decks and floors; hatches and door combings; ammunition stowage; sanitary partitions; companion ways, access trunks, etc.

Second Year

ONE MONTH.—Drawings of simple parts of machines, such as pulleys, levers, spindles, gears, cutting heads of planing and scarfing machines. This work will give considerable practice in the use of drawing instruments.

THREE MONTHS.—Practice in reading blueprints; distance between centers of rivets, etc. Interpretation of riveting tables. The drawing of floors, intercostals and lines on shell slope of keel. Drawings of keels (vertical, bilge and docking.)

ONE MONTH.—Drawing of steel forms of shear blades and parts of joggling machines (two views).

THREE MONTHS.—Instruction in the location of parts on plans used in connection with the drawings of combings, stowage; applied geometrical construction—erecting perpendiculars, parallels; reproducing angles and division of pitch circles. Practice in the location of the sea openings of a ship's hatches, gratings, port holes, shell hoists, etc., from use of offsets.

ONE MONTH.—Practice in drawing assembled frames, engine foundations, and double bottom sections.

THREE MONTHS.—Practice in drawing assembled parts of a ship; frames, lattice work for torpedo bulkheads, cage masts, etc. Location of longitudinals and lines of shell and decks from offsets. Practice in picking bars from book tables. Beginning of the study of simple shapes of expansion on irregular surfaces.

Third Year

SIX MONTHS.—Drawing of the bridge ammunition hoist, armored uptakes and views on turrets; work on compartment rearrangement. Locating deck scuppers, boat stowage supports, etc.

Considerable practice should be given at this time in "inking in." All drawings made in the third or last year should be inked, traced and a blueprint made of at least one to illustrate the principle of blue printing.

FIVE MONTHS.—Practice in making drawings from data or sketches of parts made in the shop. The apprentice should also be taught how to mark the drawings so as to show installation of parts. Transverse and longitudinal drawings from offsets of inner and outer bottoms, bulkheads, location of doors, trunks, etc., through plating and bulkheads, gun port shutters, ship ladders, floors and deck frames, splinter bulkheads; foundations, tanks, boilers, engines, pumps, gun and turret, etc. Drawings of the intersection of objects by planes at angles; as, for example, chain pipe on deck, shell hoist through turret levels, etc. Drawings involving triangulation to lead up to the drawing of developed shell plating.

ONE MONTH.—A cross-section drawing through a given frame; a longitudinal section drawing of a ship. This is given to test the apprentice's knowledge of the ship and the use of related plans.

THREE-YEAR COURSE IN ENGLISH FOR SHIPFITTERS

First Year

As arranged, one hour a week was allotted to this course.

ONE MONTH.—Practice in spelling and description of the various tools, appliances, materials and fittings used in the tool room.

FOUR MONTHS.—Short oral and written composition work based on the work of the apprentices, such as drilling, reaming, chipping and calking on various parts of the ship (deck platforms, compartments, division, etc.). Description of such terms as section, stern, port, starboard, forward, aft, and after ends of the ship; bulkheads, shell waterline, tanks (oil and fresh water), drainage, etc.; armor plate, cage masts and turrets. This practice will develop the apprentice's power of expression so that he can describe what he is doing in simple and direct English.

FOUR MONTHS.—Simple principles of grammar relating to the use of nouns and pronouns. Elementary practice in forming sentences so that the apprentice will know when and how to use capital letters and simple punctuation. Composition on trunks, ammunition, hoists, bits, etc.

Second Year

ONE MONTH.—Simple description (both oral and written) on drilling, planing, scarfing machines, on searchlight platforms and cage mast.

THREE MONTHS.—Review of the section of grammar relating to subject and predicate to show the pupil that the predicate agrees with the subject. Composition on uptakes, bridges and conning tower.

ONE MONTH.—Letter writing and shop order slips. Four types of letters: (1) to a parent; (2) to a friend; (3) to a public official; (4) to a superior official, etc. The four essential parts of every letter should be clearly brought out.

THREE MONTHS.—Practice in writing—description of shop work, with special emphasis on the division of the composition into paragraphs. Engine and boiler room foundations, ammunition stowage and boat cranes.

ONE MONTH.—Discussion and practice in writing according to the following outline: planning, manufacture and installation.

THREE MONTHS.—Composition on the turrets and bulkheads, hatches and armored decks.

Third Year

SIX MONTHS.—Considerable practice should be given at this time in both oral and written descriptions. Effort should be made to correct every-day mistakes and develop the power to write lengthy descriptions in simple, direct and concise language. Compositions may cover such subjects as method of propulsion, steering, procedure in building shell of ship, launching, etc.

FIVE MONTHS.—During this period the apprentice should write reports and descriptions of what he is doing. Emphasis should be laid on accuracy of details in describing the building of a ship—designing, planning, manufacturing and assembling.

ONE MONTH.—Written and oral composition on the economical and efficient methods of production.

THREE-YEAR COURSE IN MATHEMATICS FOR SHIPFITTERS

First Year

ONE MONTH.—Practice in solving simple problems dealing with measurements involving four fundamental operations—addition, subtraction, multiplication, and division of whole numbers. Check methods.

FOUR MONTHS.—Use of fractions and decimals in problems relating to size of taps, drills, time employment, unit costs, tapers, spacing of rivets for single and double riveted seams. Practice in making out bill forms involving percentage and discount.

FOUR MONTHS.—Problems in finding area of flat surfaces, such as triangular, rectangular, trapezoidal, hexagonal, octagonal and circular forms.

THREE MONTHS.—Problems in finding area of irregular surfaces, such as half round, half oval, hollow, channel bar, bulb, angle, etc.

Second Year

ONE MONTH.—Problems involving dimension work. Practice in calculating cost of work, which is paid for on the basis of foot thickness. Problems in distributing holes over given areas.

THREE MONTHS.—Problems on the fuel calorific values of petroleum, British thermal unit, hydraulic pressure (joggling machines, keel benders), etc.

ONE MONTH.—Problems in computing the length of diagonal frames, brackets and braces, involving the use of square root and the solution of triangles.

THREE MONTHS.—The use of the formula. Practice in interpreting formulæ and abbreviating rules into formulæ, with previous work as a basis.

ONE MONTH.—Considerable training in applied and constructional geometry, such as the erection of perpendiculars, construction of parallel lines, etc.

THREE MONTHS.—Locating centers of circles and drawing tangents. Method of finding displacements, draft underloads, and the effect of weight.

Third Year

SIX MONTHS.—Use of tables in handbooks on structural steel. Use of graphs and logarithms. The object of this work is to show the apprentice that many calculations may be shortened by the use of short cuts and logarithms.

FIVE MONTHS.—Theory and practice of the slide rule, which involves a knowledge of logarithms. Considerable practice in manipulation of the rule.

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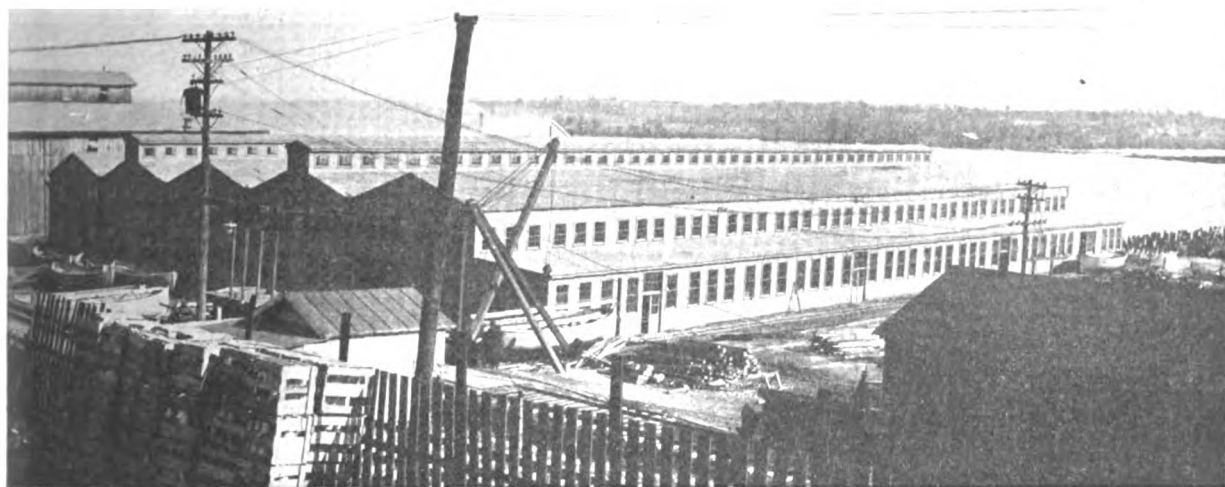


Fig. 1.—Plant of the General Shipbuilding Company, Inc., Alexandria, Va.

Manufacturing Standardized Lifeboats

**Quantity Production by Automobile Manufacturing Methods—
Number of Sizes Reduced—Parts Made Interchangeable**

BY MORRIS M. WHITAKER

UP to the time that the Emergency Fleet Corporation came into the market to supply the requirements of its shipbuilding programme, lifeboats had been built, one may say, almost as individuals. The few companies which specialized in them were, with one or two exceptions, small, and had no facilities for production in quantity, nor had they room or capital for expansion.

Each company had been in the habit of building an extended list of sizes, and each had its own models and specifications. In one instance, a company built fifteen sizes. The situation was further complicated by the fact that the rules of the United States Steamboat Inspection Service required a type of steel a little higher than the commercial grade, and also that the steel entering into the construction must be tested. Further, the gage called for was not the one used commercially, and few of the steel companies cared to roll this special stuff when the volume of business was so small.

PRODUCTION CAPACITY OF LIFEBOAT BUILDERS LIMITED

Under conditions such as these, the Emergency Fleet Corporation found it extremely difficult to place large orders, for the difference in the specifications of the boats offered made it almost impossible to decide between the actual value of the boats and the diversity of model complicated the installation on the ships. However, as the necessity was great, the Emergency Fleet Corporation placed orders for all the boats the various companies could take and loaded them up for months ahead. Luckily the demand was not for immediate delivery and this gave the various companies with orders a chance to obtain material, which, however, was slow in delivery, and at times the Fleet Corporation was hard pressed to get the necessary lifeboat equipment for ships fitting out.

The Fleet Corporation early realized that here was an excellent field for standardization and set about getting out its own plans and specifications. When these were

complete it was in a position to order in a quantity which would permit of manufacture.

First of all, in getting out its plans and specifications, it was necessary to reduce the number of sizes, which was finally cut to five, built to the following lengths: sixteen, twenty, twenty-four, twenty-six and twenty-eight feet. The gage of metal for shell plating was reduced to two sizes and these were made to correspond to the United States standard. Parts and fittings were made interchangeable between the sizes in so far as this was possible under the Steamboat Inspection Service rules. For instance, the gunwales of certain sizes were interchangeable, sails were made so that two sizes covered all five sizes of boats, three sizes of tanks served all five sizes of boats, and all these were made cylindrical instead of shaped, thus saving material and labor. The different sizes of cars required was brought down in number, and the outfit required by the rules was made standard for all sizes. The sizes of sheets for plating and tanks were standardized, which permitted a considerable saving in ordering. The Emergency Fleet Corporation ordered this in quantity from the manufacturers and distributed it to the builders. In this way the cost of the boats was brought down, in spite of the increased cost of both material and labor, and a greater production was made possible. This procedure also simplified the work of the shipbuilder in installation of boats and davits and gave him boats in anticipation of his requirements.

QUANTITY ORDERS GIVEN TO NEW COMPANIES

With the establishment of its standards, the Emergency Fleet Corporation placed a number of quantity orders with companies not heretofore doing this class of work. Among these was the General Shipbuilding Company, Inc., Alexandria, Va., which was organized at about the time the United States entered the war and which had built a number of submarine chasers for the Navy Department.

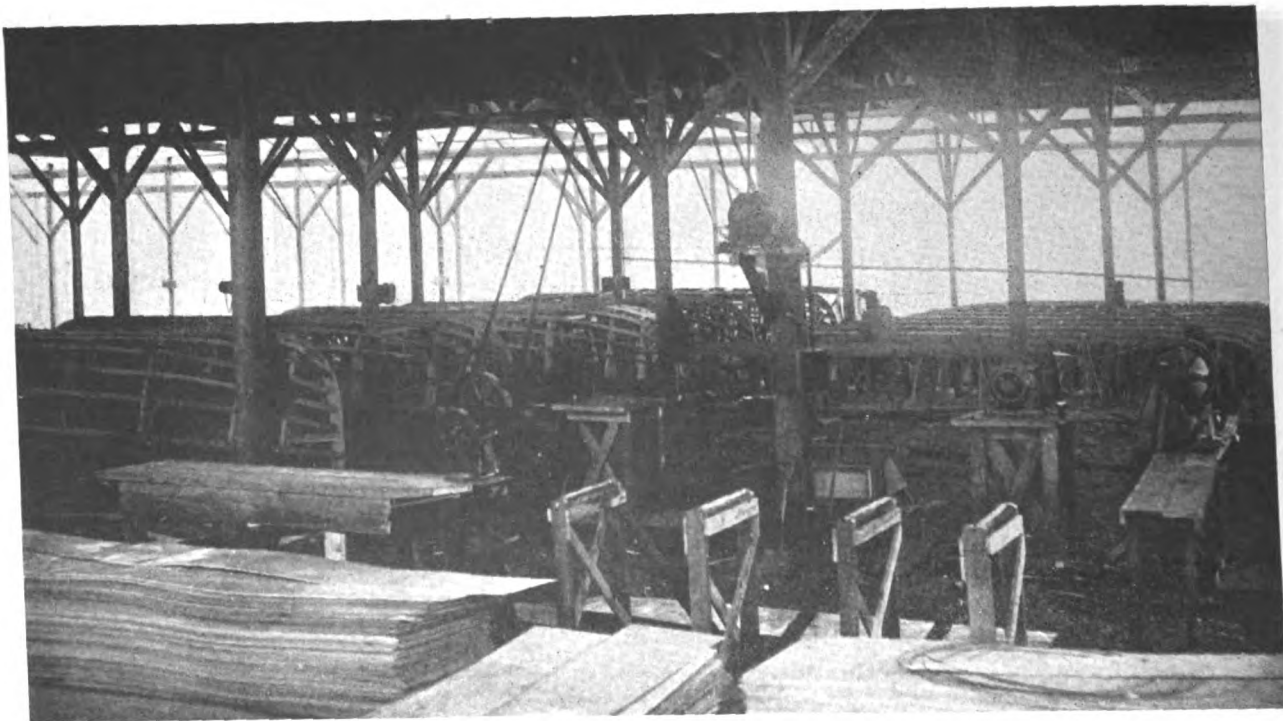


Fig. 2.—Molds on Which the Lifeboats Are Shaped

This company immediately set about building a plant for this special work and went into the matter thoroughly from a manufacturing standpoint. A part of its property, formerly used for lumber and timber storage, was cleared, graded and leveled and a building 224 feet long and 165 feet wide, with 18 feet clear head room, was erected. The plant was laid out east and west, with five bays or runways and a lean-to for storage along the south side. Each bay or runway was wide enough for the construction of two boats, side by side. This allowed work on ten boats at the same time.

LAYOUT AND ARRANGEMENT OF GENERAL SHIPBUILDING COMPANY'S PLANT

Machinery for cutting the plating, punching and bending it was installed in the southeast corner, with other tools, racks, molds and fittings extending across this end to the northeast corner. Ten building or forming molds were installed, extending across the building from north to south. The process of manufacture is progressive from east to west through the building. Each boat moves at each operation or series of operations, starting as a bare keel at the east end and coming out as a completed boat at the west end. At the west end of the building is a switch track extending across the whole length of the front, with a three-leg derrick at the southwest corner for unloading material and loading completed boats.

Work on the boats was started before the building was completed. Construction work on the building began at the south side and worked across, so that the boats were actually completed in the south bay before the last bay on the north was closed in.

In the manufacture of boats the system used is as follows:

SYSTEM OF MANUFACTURE

Materials of all kind come in at the switch track. If they are such as require no further manufacture, they are shifted from the switch track by a light railway, running along the south side of the building, to a point in the lean-to storehouse nearest to the operation where they are to be used. If they require manufacture, they are shifted by the light railway to the point of manufacture. Thus, steel for plating goes to the extreme southeast corner, close to the cutters. If the material is for keels, it is carried by another light railway to the northeast corner, where it is bent, punched and otherwise prepared to go on the keel molds. If the material arriving is lumber, it is unloaded farther south on the switch alongside the company's mill, and when worked to the form of completed parts, it is carried across the yard to the lean-to storeroom by another light railway and deposited at the point most convenient for its use in the progressive manufacture.

PROCESS OF CONSTRUCTION

In the actual construction of the boats the process is as follows:

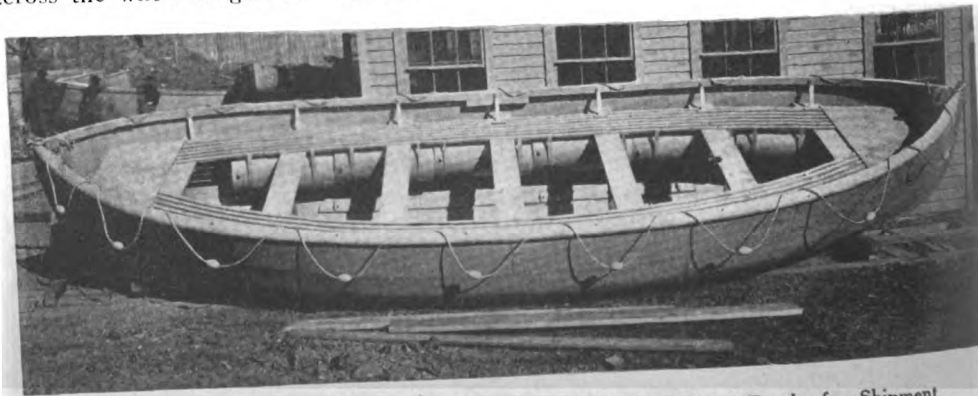


Fig. 3.—Completed Emergency Fleet Corporation Standard Lifeboat Ready for Shipment.



Fig. 4.—View in One of the Runways, Looking Across the Shop

The steel for the plating is stored at the southeast corner, each size in a pile by itself. The different strakes and plates are marked from steel templets and start north across the end of the building. First they pass through the cutters, from these to the gang punches, then to the storage racks for plates, ready to use, located near the center of the east end.

MATERIAL IS BROUGHT TO THE WORKMEN

The bar for the keel comes into the northeast corner, where it is bent, punched, and the brackets for the dropping gear are riveted on by air hammers. It is then picked up by an overhead conveyor and put on one of a set of molds at a convenient height for the forming and riveting of the garboard strake.

This strake of plating is taken from the racks and formed by breaks and rolls, conveniently located, and attached and shaped to the keel, to which it is riveted by air hammers. It is again picked up by the overhead conveyor and, through a system of switches, placed on a vacant mold, where the plating is completed.

Each plate when it leaves the racks is punched on one side and one end. As the plating of the boats is lap strake, the unpunched edge of the seam is punched by hand and riveted to its adjoining plate at several places to hold it in position. As soon as the plating is completed, the boat is removed from the mold by the overhead conveyor and shifted ahead about its own length and turned over.

The next step in construction is the installation of the gunwales, previously prepared, so as to stiffen up the structure sufficiently to permit of punching the remaining rivet holes and riveting them up. The boat is then again moved down the shop for the punching of the bottom and sides for the installation of the toggle straps for the footings and the U plates for the thwarts.

Other steps in the manufacture of the boats are installation of dropping gear, placing of footings, thwarts, side benches, end platforms, tanks and painting and installing gear and outfit. At each step or combination of steps the boat is moved down the runway to the west, and by the time it arrives at the west end of the runway it has been inspected and is ready for shipment.

Each operation or series of operations is timed for a working day, and a sufficient number of men to put it through in this time are assigned to this work. These gangs of men do one operation only and then pass the boat along to the next gang. Materials for each operation are located in the lean-to abreast the operation and travel across the shop, messengers being used for this work so that each man has his material brought to him at the point where he uses it.

Each part of the boat is made to a master templet and is carefully inspected before going into the finished material store, with the result that there is little or no fitting to be done in the progress of the work. The product is remarkably uniform in quality.

OUTPUT OF THE PLANT

In general, a boat is started each morning on each mold and one is finished each night at the shipping door of each bay. The period from putting the keel on the mold to shipment averages about four days, although this varies somewhat with labor and material conditions, for the absence of a few workers in the different operations, or the lack of some part, due to railway conditions, upsets the smooth flow of production.

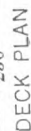
When working all bays on one size of boat, the annual capacity of this plant is about 3,000 boats per year, without any overtime. If working on varied sizes, this production would be cut somewhat. At present, daily shipments are being made by rail and an occasional shipment by water.

New Edition of Aldrich Marine Directory Issued

The 1919 edition of the Aldrich Marine Directory, just issued by the Aldrich Publishing Company, New York (price, \$5), contains 230 pages, 4½ by 8¼ inches. The directory contains lists of concerns which build and repair vessels in the United States, and also of steamship, steamboat and other vessel owners operating ships under the American flag. The shipbuilders' list comprises nearly 500 shipbuilding or repair yards, which have a total of nearly 2,000 launching ways and about 400 drydocks and marine railways.



Fig. 1.—General Plans of Upper Mississippi River Open Hopper Type Barge. Length of Hopper, 256 Feet; Width of Hopper, 36 Feet



DECK PLAN

Fig. 2.—General Arrangement Plans of Cargo-Box Type Barge for Lower Mississippi River Route. Length, 230 Feet; Beam, 46 Feet; Depth, 11 Feet

Revival of Mississippi River Traffic—II

Towboats and Barges of the "Upper" and "Lower" Mississippi River Fleets—Plans and Details of Construction

BY M. VON PAGENHARDT*

THE nineteen river barges for the "upper fleet," as the St. Paul-St. Louis iron-ore fleet begins to be called, in comparison with the "lower" or St. Louis-New Orleans fleet for general freight transportation, are of the open hopper type. The main deck is sunk to a point halfway between the deck and the bottom of the barge, leaving a deck stringer of 6-foot width on either side of the hopper. The hopper is 256 feet long (85 percent of the length of the barge) and 36 feet wide. One watertight center keelson and two side keelsons provide longitudinal

one at each end of the barge. When in tow, the tiller-line is taken around the capstan, which is designed to work in either direction. The deck equipment includes two 2,000-pound stockless anchors, a special design of cable-stopper mounted on a turntable, cable reels, anchor davits and fenders. In order to insure absolute "watertightness" under all conditions, all deck openings are closed with watertight hatches, and the oil vents are of the self-closing type, in case the deck coaming should be under water.

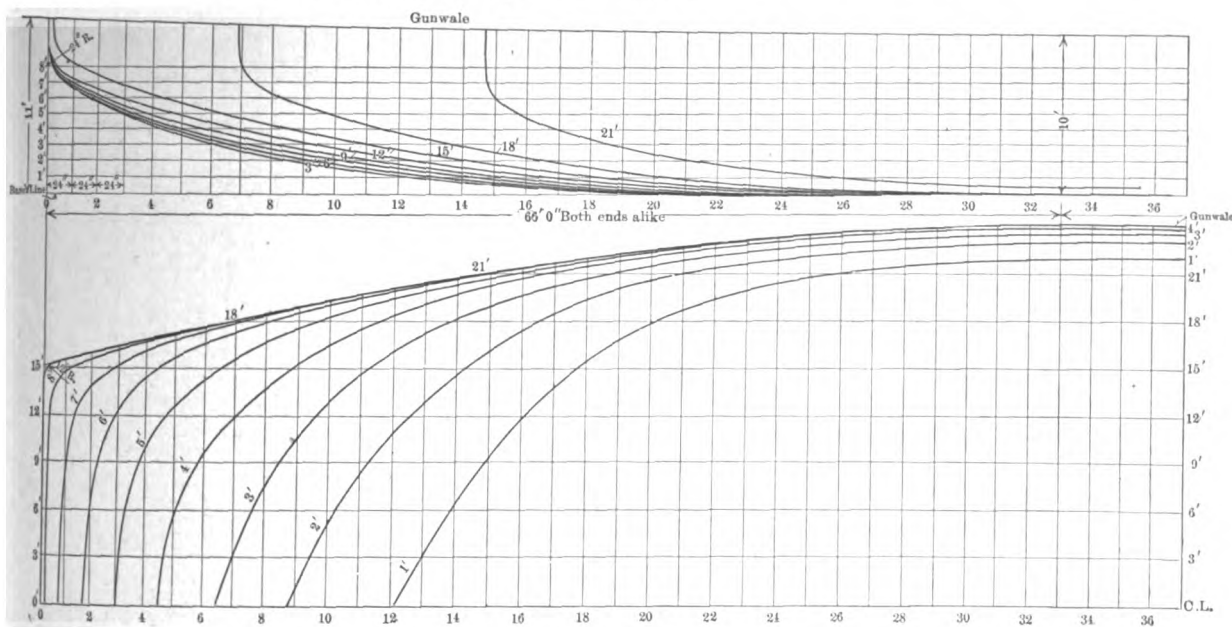


Fig. 3.—Molded Lines of Upper Mississippi River Barge

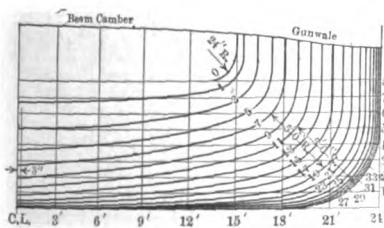


Fig. 4.—Body Plan of Upper Mississippi River Barge

stiffness, and twelve transverse bulkheads, spaced 24 feet apart, provide sufficient transverse strength. There are, altogether, twenty-four watertight compartments.

A complete oil pipe and bilge system is arranged both for filling and emptying the barge, in case fuel oil is carried in the double bottom. For this purpose a 10-inch by 10 $\frac{1}{4}$ -inch by 12-inch duplex horizontal steam pump is installed in the pump room, together with a 6-inch by 6-inch double barrel beam hand pump. Oil filling and discharge pipes, as well as steam connections, are arranged on deck on either side of the barge.

In order to permit towing on a line and in either direction, each barge is equipped with two detachable rudders,

*Naval architect, St. Louis, Mo.

The contract for the nineteen steel barges was given to three contractors, six to the Dravo Contracting Company, of Pittsburgh; seven to the Dubuque Boat & Boiler Works, of Dubuque, Ia., and six to the Marietta Manufacturing Company, of Point Pleasant, W. Va. The contractors were required to submit a uniform bill of material and guarantee a uniform method of construction. To carry this out, they retained the services of C. E. Smith & Company, naval architects and consulting engineers, of St. Louis, to make the detail drawings.

UNIFORM RIVET SPACING

Instructions were given to lay out the work for multiple or rack punches. It was planned to fabricate the straight part of the barges, which covered almost three-fifths of the total steel weight of 500 tons, in outside structural mills. Since these mills were inexperienced in barge work, details had to be made for each plate. It was found that equal rivet spacing for the entire length of seams and butts was not possible, if the different conditions covering "watertightness" and strength of seams and butts, crossings of adjoining laps, frames and bulkheads were properly observed in accordance with the rules of the American Bureau of Shipping and the Government specifications. It would have been desirable, for example, to space

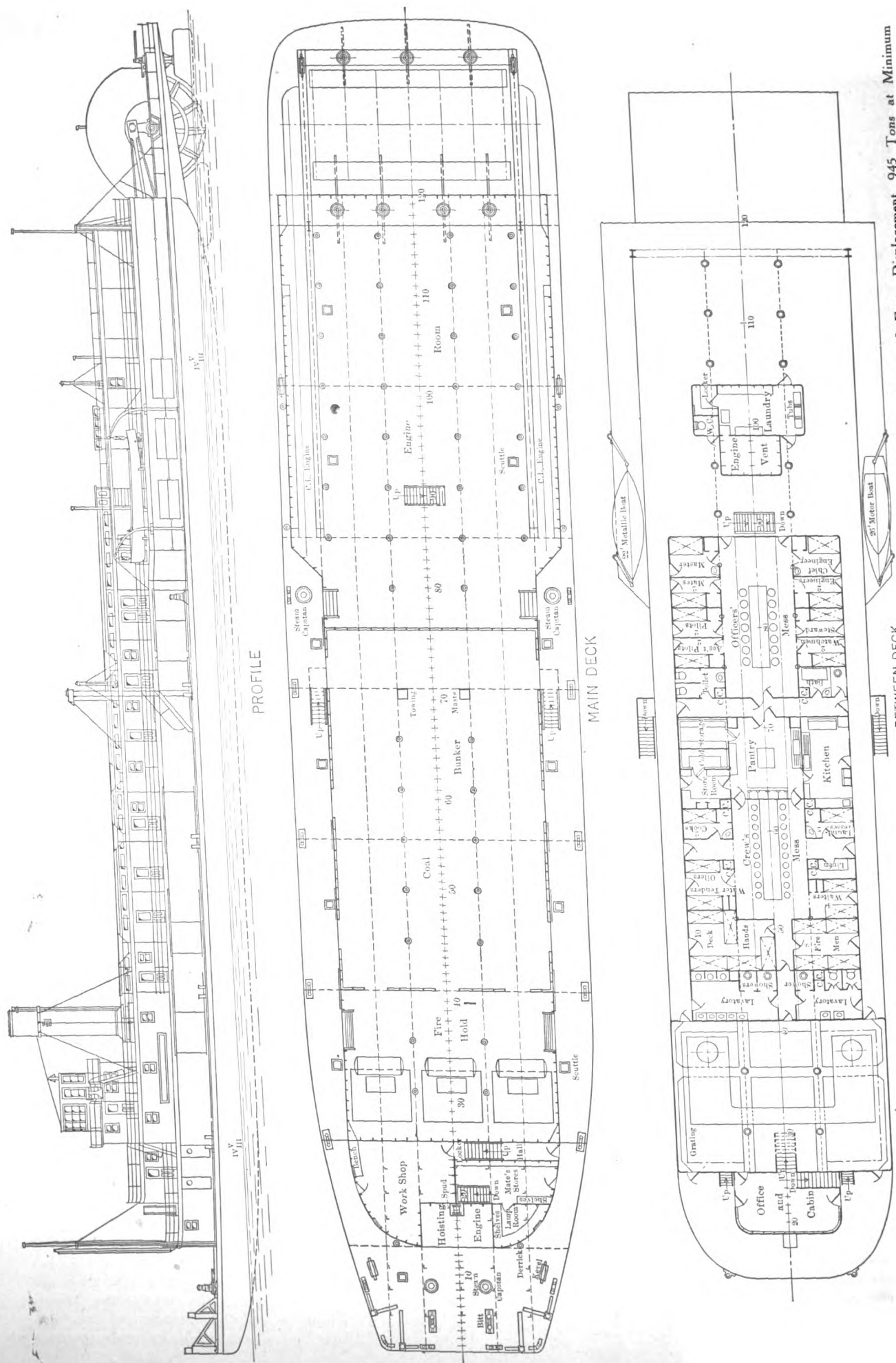


Fig. 5.—Upper Mississippi River Steel Towboat. Length Overall, 265 Feet; Length Between Perpendiculars, 230 Feet; Beam, 58 Feet; Depth, 8 Feet; Displacement, 945 Tons at Minimum Draft of 3 Feet; Indicated Horsepower, 1,600

all rivets on the 24-inch frame in equal distances of 2.4 inches, that is, ten spaces to the total length. But as the specifications called for $2\frac{1}{4}$ -inch rivet spacing for $\frac{5}{8}$ -inch rivets and $5/16$ -inch plates, and as all butts had to be triple riveted, a uniform "panel" spacing was adopted instead of a uniform "rivet" spacing. All panels were spaced equally—ten spaces of $2\frac{1}{8}$ inches and one space of $2\frac{3}{4}$ inches, making the total of 24 inches.

Wherever possible, uniform spacing was adopted in seams and butts, and odd spacings of $1\frac{7}{8}$ inches or

UPPER RIVER TOWBOATS

The four new upper river towboats are of the stern paddle wheel type. The dimensions are 230 feet from stern to transom; 58-foot beam and 8-foot depth, displacing 945 tons, with a minimum draft of 3 feet. The length overall is 265 feet, including the stern wheel and the stern guards protecting the auxiliary rudders.

The design is an evolution of the old-fashioned stern-wheel towboat, retaining its well-proven good features, but otherwise following strictly the principles of modern

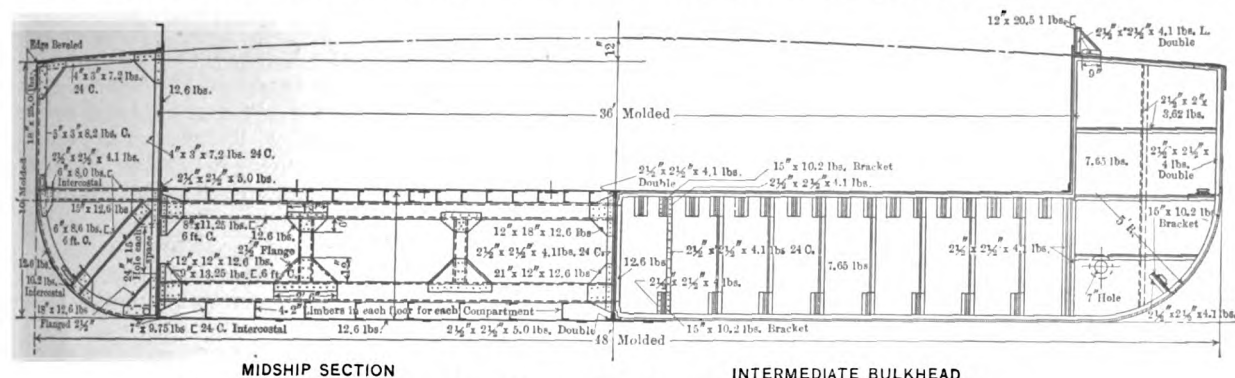


Fig. 6.—Midship Section of Open Hopper Type Barge for Upper Mississippi River Route

2½ inches were changed to equal spacings of 2 inches and 3 inches, respectively, wherever an increase in the efficiency of the butt was desirable. To insure uniform spacing of rivets in frame and gunwale angles, a system was evolved which would make all spaces from 1 foot up to 23 feet identical, so that the mold loft work and the work of supervision were greatly simplified, inasmuch as only a limited number of master templets was required,

naval architecture and mechanical engineering. The hull is designed as a structural unit, including the heavy stern-wheel overhang. Instead of supporting this weight by hog chains and king posts, the necessary stiffness is provided by running the sides of the deck house past the stern-wheel shaft supports and by reinforcing the middle or between deck so as properly to take care of the longitudinal stresses. The distribution of the weights, by

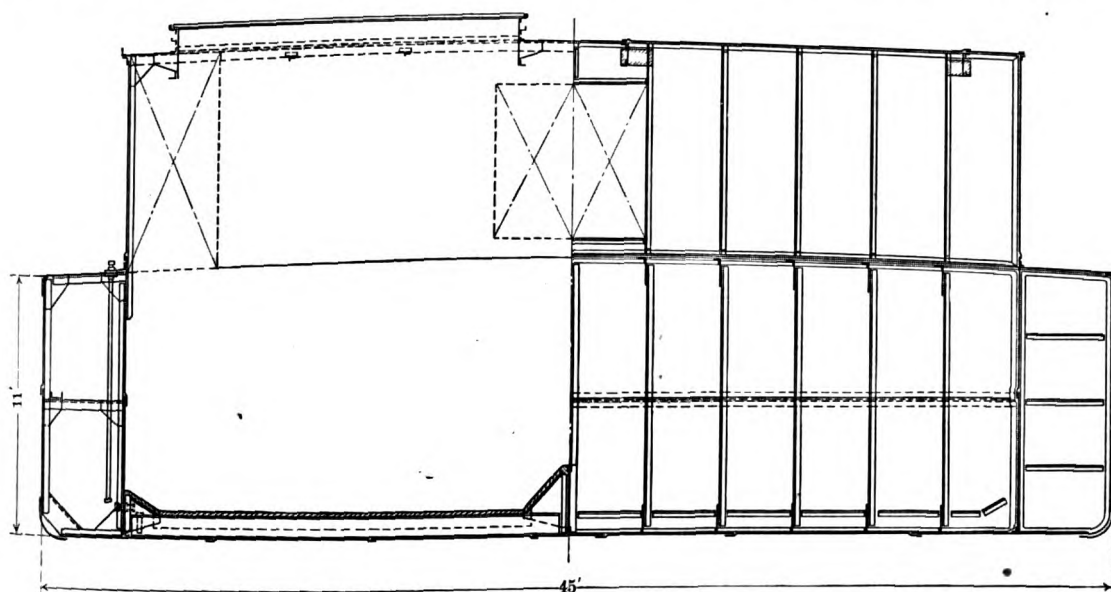


Fig. 7.—Midship Section of Cargo-Box Type Barge

and all equal distances had equal rivet spacings throughout the length of the vessel.

Great care was observed in the bill of material. A large part of the structural shapes, particularly the channels, were ordered the exact length, in order to save cutting at the yard. The same care was used in the laying out of the pipes and fittings of the complete oil pipe and bilge system, and in planning the fire steam smothering system, so as to reduce the cost of material and of special labor to the minimum.

placing the wheel and machinery aft and boilers and coal forward, produces considerable static stresses. Immeasurably higher, however, are the dynamic stresses produced by the working of the wheel, particularly in grounding the vessel.

The main engines are designed to develop 1,600 indicated horsepower at normal working load with a 20 percent overload capacity, and the power is absorbed by a stern wheel 22 feet in diameter and 42 feet long, having only twelve buckets 3 feet 6 inches wide. A thrust of

50,000 pounds is required in a dock test with a mean speed of 12 miles per hour, running with a draft of $4\frac{1}{2}$ feet. The engines are of the tandem compound type, 24-inch high pressure, 50-inch low pressure and 8-foot stroke, designed for 250 pounds pressure and 24 revolutions per minute. A double set of pitmans, crossheads and slides are arranged to bring the heavy machinery weight well toward the center of the vessel. A circular steel shell condenser with cast steel heads and 3,600 square feet of cooling surface, together with circulating and air pumps, is mounted abreast the low pressure cylinders.

BOILER EQUIPMENT

The boiler battery is either of the straight watertube or the combination fire and watertube type, capable of evaporating 50,000 pounds of water per hour. The battery was designed for the use of Illinois bituminous coal, having large furnace room. The total heating surface is required to be not less than 10,000 square feet, including

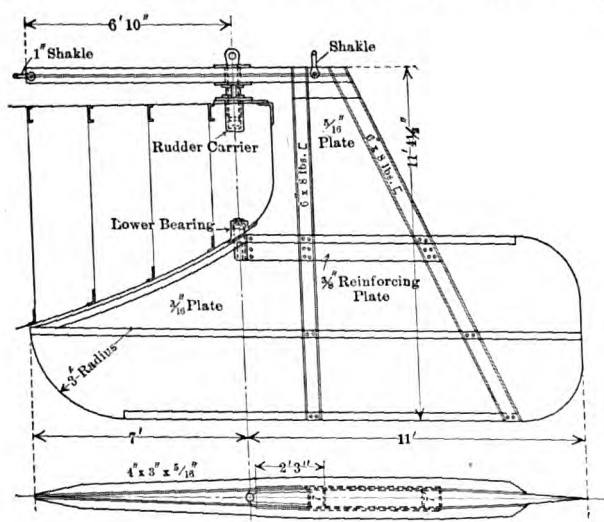


Fig. 8.—Details of Rudder of Upper River Barge

superheaters capable of 75 degrees superheat and feed-water economizers capable of raising the feed water to at least 350 degrees F. Both forced and induced draft are to be installed under each boiler.

ENGINES FOR UPSTREAM TOWING

The deck machinery includes four capstans, one winding engine placed on the forward deck—capable of 100 tons pulling capacity—two towing engines placed on the boiler deck, handling $\frac{7}{8}$ -inch hawsers, six conveyor units for handling coal, spud-raising machinery, and electric generators for day and night service.

The introduction of towing engines is expected to prove of greatest value in handling the tow on the upstream voyage. The method of towing barges on a line is not expected to be used in downstream work, but having proved so advantageous elsewhere in upstream towing, mounting rapids and maneuvering through locks, the towboats are properly equipped with engines carrying 1,500 feet of hawser, and the wheel, cranks and pitmans are entirely enclosed to facilitate the handling of the tow. Naturally, the boats are equipped with the well-proven auxiliary rudders aft of the stern wheel.

The auxiliary machinery includes ballast and bilge pump, domestic pump, exhaust steam feed-water heater and evaporator, steering engine, ice machine and air compressor. The outfit includes one 26-foot motor boat, with a speed of 12 miles per hour, one lifeboat, one work boat

with detachable 5-horsepower motor, and all necessary lines, hawsers, chains, tools and spares.

Accommodations are provided for a crew of thirty-four officers and men.

Particular care has been given to the attainment of maximum power with minimum displacement and minimum draft. The accomplished result, 1,600 to 2,000 indicated horsepower on 945 tons displacement, or about 2 indicated horsepower per ton, is at least 50 percent superior to any towboat power applied to date on western river stern-wheel towboats.

LOWER RIVER BARGES

The forty steel river barges of the "lower" or merchandise fleet, to operate between St. Louis and New Orleans, are 230 feet long, 46 feet wide and 11 feet deep. Contract has been let for twenty-five of these barges to the American Bridge Company, of Ambridge, Pa., and for fifteen to the Dravo Contracting Company, of Pittsburgh, Pa. The original plans and specifications called for all-steel merchandise barges of the cargo-box type with sunken deck construction, similar to the upper river barges, but differing in the form of the ends.

Instead of adopting the modified form of the scow with sides well drawn in and well-shaped bilges, in accordance with recommendations of the United States Experimental Towboat Board for upstream towing, the designers, Cox & Stevens, of New York, adopted the simpler form of straight scow, possibly as a compromise to the builders. The additional resistance of this form of barge over the resistance of the modified form on the 1,200-mile upstream haul will, in the writer's opinion, be a most serious handicap in the ton-mile capacity, as the earning capacity of the barges for their entire life is based upon that factor.

As an additional compromise, the sunken steel deck was later dispensed with by request of the War Industry's Board, in order to save 20 percent of the required steel. As a substitute, a yellow pine floor was ordered to be laid directly on the floors. This action automatically excluded the possibility of carrying fuel oil in bulk in the double bottom, and also did away with the oil pipe and bilge system required for the discharging and filling of the hold compartments. The declaration of the armistice should have altered the underlying necessity for the War Industry's decision.

The writer understands that action has been taken to replace the steel material for the wooden floor, thus restoring the double or sunken deck construction. River barges should be built with the same care and foresight as ocean-going ships. Negligence in construction accounts for the greater part of the losses in river floating equipment.

LOWER RIVER TOWBOATS

The six new lower river towboats are of the twin tunnel screw type. The dimensions are 200 feet overall, 40 feet wide and 10 feet deep, displacing 1,050 tons with a draft of 6 feet. The design is an enlargement of the tunnel towboats *L. A. Rumsey*, *A. M. Scott*, *Inspector* and *Claireton*, all built by the Ward Engineering Works, of Charleston, W. Va. The contract for the building of two of these vessels has been let to the Charles Ward Engineering Works, and, for the other four, to the Marietta Manufacturing Company, Point Pleasant, W. Va.

The design, which was made by Cox & Stevens, of New York City, acting for the United States Railroad Administration, embodies the suggestions of the experienced tunnel boat builders, the Ward Engineering Works.

The steam power of the vessel is named as 1,800 indi-

cated horsepower, which is absorbed by two screw propellers 9 feet in diameter and of 9-foot pitch. As the vessel is permitted a draft of 6 feet, two-thirds of the screw is fully submerged, which is fully in line with the experience gained on other vessels of this type. The two main engines are, according to the contractor, of the standard Emergency Fleet Corporation pattern, developing 700 indicated horsepower, with 150 revolutions per minute. The engines are expected to develop 900 indicated horsepower each, when turning 190 to 200 revolutions per minute, the piston speed in this case—with cylinders of 26-inch stroke—being 870 feet per minute, which is relatively high.

The boiler battery is of the straight watertube type as built by the Ward Engineering Works, with a heating surface of 8,000 square feet, fuel oil being used as fuel. Superheaters and feedwater economizers are not specified. The capacity of the boiler battery is required to be 32,000 pounds, with an overload factor of 25 percent, bringing it up to a total of 40,000 pounds.

The auxiliary machinery includes a surface condenser of 2,400 square feet, with all circulating, air and feed pumps, a fire pump, a bilge and ballast pump, sanitary

pumps, and steering engine. The deck machinery includes four steam capstans and two electric generators.

The selection of the tunnel screw boat for the entire six towboats of the lower river division—St. Louis to New Orleans—in preference to the stern-wheel towboats, is looked upon with some misgiving. This tunnel screw towboat is unqualifiedly entitled to recognition. There is at this time in service the *A. M. Scott*, a boat of 600 indicated horsepower, and the *Claireton*, a boat of over 1,000 indicated horsepower. These boats have proved equal to any stern-wheel towboat of the same power, both in push and in handling ability. They are operating on a draft of $3\frac{1}{2}$ and $4\frac{1}{2}$ feet, respectively, turning twin propellers of 60 and 80 inches diameter.

There is, however, a certain amount of experiment attached to the tunnel type towboat of still larger power, inasmuch as a twin screw tunnel boat of 1,800 indicated horsepower has never been built before. On the other hand, there is absolutely no question about what a stern-wheel boat of such power will do, and that it will be satisfactory in push and handling ability even without the improvements introduced in the upper river towboats.

(To be concluded.)

Marine Diesel Oil Engine Problems—II

Discussion of Probable Size of Diesel Engines—Methods of Balancing—Construction of Mufflers—Cooling Systems

BY JOHN W. ANDERSON

THERE is one difficulty with the gravity lubrication and the mechanical oiler, and that is, that there are many parts and pipes to consider, and each pipe or lead requires a certain amount of individual attention in order to see that the proper amount of oil is being supplied to that particular part. Furthermore, with these systems only just enough oil with a slight margin is provided to cover the necessary requirements of the bearing.

The big advantage of the forced lubrication system is that a good surplus is supplied to each bearing at all times and distribution of the oil is secured by the proportions of the various passages, and hence requires no attention on the part of the operator other than to make sure that the main supply to the engine is kept up. Of course the various passages must be kept clear and open, but this is a matter that can be readily attended to during the overhauling period and there is very little tendency for the oil to plug up the passages during operation.

There is one thing in connection with forced lubrication that is extremely important and requires constant watchfulness on the part of the operator, and that is the question of salt-water leaks into the lubricating oil. Any leak into the crankcase, no matter how small, forms an undesirable mixture with the lubricating oil and at moderate temperatures creates a deposit which will quickly plug up the passages. If special precautions are taken against the leakage of the salt water into the oil and the condition of the oil is watched carefully at all times, there is little chance for difficulty in this direction. From every other standpoint forced lubrication has the advantage over other methods. The proof of this is best shown by the increasing adoption of this system on engines of all types and sizes.

With an open-frame engine, and using special precau-

tions so that lubricating oil from the working cylinders does not drip into the crankcase, the oil does not become foul except after long service, but with the closed-crankcase trunk-piston engine the lubricating oil soon becomes fouled with finely divided carbon particles. After a time the oil turns very black and viscous and tends to clog the oil passages. This requires as much as 3,000-hours' running in some cases, while in others this condition obtains in a few hundred hours. It is understood, of course, that oil is added from time to time to make up for the losses, but the system is not cleaned out and the whole supply replenished in all this time. As this condition of the oil is approached, the danger of bearing troubles increases, and if it can be voided the oil ought never to be allowed to get into such a condition.

Most of the carbon particles are removed by filtering and the filtered product approaches the original in all its properties, except that it is darker, due to the presence of the particles which were not removed by filtering. The centrifugal process of clarifying is even better than filtering and removes a larger proportion of the carbon particles.

To attempt to filter or clarify the oil each time it is circulated through the engine would imply the addition of too much apparatus to take care of such a quantity of oil, and fortunately it is unnecessary. The best way is to drain out the system at regular intervals, depending upon the type of engine and the conditions of the service, and fill up with fresh oil. The fouled oil can be filtered at leisure and kept for future use.

SIZE OF DIESEL ENGINES

The Diesel engine industry is still so young that the question of how large an engine can be built is one that cannot readily be answered at this time. Practically all

of the engines in service to-day are of small and moderate power as compared with certain steam plants, but, on the other hand, big strides have been made in the last few years in the development of large units. The largest two-cycle marine engines in actual operation to-day are the two engines in the U. S. S. *Maumee*. These engines develop more than 2,500 horsepower in six cylinders, or about 425 horsepower per cylinder.

In the marine field there are very few four-cycle engines which even approach the cylinders of these engines in size, which means that the actual horsepower developed is much less than for these two-cycle engines in the *Maumee*. It must be remembered that these particular engines were designed four years ago and now have been in operation long enough to show that they are an unqualified success. The troubles developed with them have been of a very minor nature and are largely due to the lack of sufficient experience with this size of engine. New engines of a similar type and size could be built to-day and no trouble whatever would be expected with them. By trouble is meant something beyond the ordinary care and overhaul which any piece of machinery requires. The successful operation of these engines indicates that all ships requiring 5,000 shaft horsepower or less, and this will include practically all ocean-going vessels built for cargo-carrying purposes, can be successfully equipped with Diesel engines.

Several European firms have experimented with single-cylinder units of approximately 2,000 horsepower per cylinder, but, so far as is known, these engines have never gotten beyond the experimental stage, probably due largely to the present war, which has undoubtedly retarded the development of large engines. Large double-acting, four-cycle stationary units have been in successful operation in Germany for several years. These engines have been built up to a size of 500 horsepower per cylinder. The *Maumee's* engines, if made double-acting, would develop over 800 horsepower per cylinder. In view of what has already been done and the experimental work that has been undertaken by so many firms, it is undoubtedly only a question of time when Diesel-engine power will be available for all except the very fastest liners and warships.

BALANCE

The vibration produced by an engine depends largely upon the number of cylinders and upon their arrangement. In commercial work, generally speaking, the speed is slow enough and the hull heavy enough, so that the matter is not one of great importance, but in the case of a high-speed engine in a light hull it is absolutely necessary that the engine be properly balanced.

For commercial work many four-cylinder, four-cycle engines have been built, and these engines are very badly out of balance, due to arranging the cranks all in one plane to get the best turning moment. But, as already stated, where these engines have been installed no serious difficulty has resulted, due, undoubtedly, to the relatively low revolutions and the small size of the engine as compared with the hull.

If good balance is desired, it is necessary to use six or eight cylinders, which can be made to give the best turning moment and a good balance at the same time. The only thing that interferes with giving these engines a perfect balance is the air-compressor cylinders, but the reciprocating parts of these compressor cylinders are comparatively light and hence do not cause any serious difficulty. In the case of crosshead engines it is oftentimes convenient to drive the compressors by beams and links from the crossheads. On a six-cylinder, four-cycle

engine, for instance, there might be three compressors driven from three of the cranks, or on a six-cylinder, two-cycle engine three compressors would be driven from three of the crossheads and three scavenger pumps from the other three, so that a practically perfect balance would be obtained.

FUEL SYSTEM

The usual method for the fuel system is to carry the main supply of fuel in the double bottom or in tanks in parts of the ship that are not ordinarily otherwise used, and then provide pumps for pumping it into gravity tanks placed well up in the engine room so that the fuel can flow by gravity from the tanks of the engines. The tanks are made large enough to hold at least several hours' supply and oftentimes a whole day's supply, so that the fuel has plenty of time to settle and any sediment or water will collect at the bottom of the tank, where it may be drained off. It is very necessary that the fuel supply to the engine be perfectly clean. Very small particles of dirt or foreign matter will stick in the valves on the fuel pumps on the engine and cause no end of trouble. There is only one way to avoid getting this dirt into the engine, and that is to filter the fuel properly. The filter is sometimes placed between the gravity tank and the engine and is sometimes combined with the gravity tank. In case the gravity tank is of small capacity, it is generally placed on the discharge side of the pump, which pumps the fuel from the main tanks to the gravity tank.

The arrangement of the exhaust piping depends upon the type of the boat and the conditions of the installation. In the case of small boats where the waterline is more or less fixed and very little rough water is encountered, an underwater exhaust works out very satisfactorily, but in the case of large ships the exhaust must be carried up a stack. In twin-screw boats it is essential that the exhaust from each engine be kept separate so that it can be watched by the operators. One of the simplest methods of detecting faulty operation in a Diesel engine is to watch the exhaust. The least sign of smoke is a sign of poor combustion and should be investigated at once.

MUFFLERS

Many varieties of mufflers are used. The main idea of all of them is to break up the pulsations in the flow of the gases and give a steady flow. Where there is plenty of space and weight available, a big expansion chamber serves fairly well, but it is much better to reduce the size and use baffle plates. One of the best types is one in which the gases enter a cylindrical chamber tangentially at the circumference and escape at the center, or vice versa. Cooling the gases by turning the cooling water from the engine into the exhaust pipe helps, too, but is not used except in some special cases. If there is very much sulphur in the fuel, water combines with the products of combustion and forms sulphuric acid, which will in time destroy the exhaust piping. If, however, the entire quantity of the cooling water passing through the engine is turned into the exhaust, the mixture is so diluted that there is little danger of trouble.

The piping itself must be jacketed or lagged and due allowance must be made for expansion. Water-jacketing is in most cases more satisfactory, but it adds to the complication and cost of the system and for that reason is oftentimes avoided and the pipes are lagged.

Many ships have been fitted with boilers or heaters for using the waste heat in the exhaust gases. No great quantity of high-pressure steam can be produced on account of the comparatively low temperature of the exhaust gases. At full power this temperature is around 700

and 800 degrees F., but at ordinary sea speeds this temperature drops to around 600 degrees F. or even less. This is particularly true of naval vessels where the maximum speed is considerably higher than the cruising speed, and hence the exhaust temperature may drop as low as 400 degrees F. when cruising. However, there is considerable heat available. Speaking broadly, the heat given off in the exhaust gases is about equal to the equivalent useful work done by the engine. This heat can best be used for the production of low-pressure steam for heating purposes. To take care of conditions when the engines are stopped, a fuel-oil burner can be fitted to the boiler and the same fuel used directly in the burner as is used for the engines.

COOLING SYSTEM

The question of cooling the various parts of a Diesel engine is an important one, but as far as the fixed parts are concerned the problem is simple for all ordinary sizes of engines. It is only necessary to provide for the proper flow of the cooling water, avoiding all pockets and dead areas. In the case of nearly all two-cycle engines and in four-cycle engines of quite moderate size, it is necessary in addition to cool the working piston, and herein lies a real problem. There is no exact dead line below which cooling is unnecessary and above which cooling is necessary, as a great deal depends upon the conditions of operation; that is, a high-speed engine designed to be driven at a heavy overload might require cooling, while the same engine driven at a lower speed and moderate power would operate perfectly satisfactorily with uncooled pistons. It is simply a question of carrying away the heat absorbed by the top of the piston. If it can be carried off fast enough through the cylinder walls to keep the center of the piston head from getting too hot, then the pistons do not need to be cooled, but if this is not so, then the extra heat must be absorbed by the circulation of a cooling medium through the piston. In general, it may be said that two-cycle engines developing 50 brake horsepower or more per cylinder and four-cycle engines developing 150 brake horsepower or more per cylinder are better off with cooled pistons.

The difficulties in the way of successfully cooling the piston are best shown by the variety of substances used and by the various devices employed to carry the substance to and from the piston. The simplest method is to employ a jet of air, but this is not very effective and can be used only where the cooling effect required is very slight. The other three substances employed to any extent are lubricating oil, fresh water and salt water. Lubricating oil has the distinct disadvantage that its specific heat is only about 0.4 of that of water, and hence about $2\frac{1}{2}$ times as much must be circulated to carry off the same amount of heat within the same temperature limits. In addition, oil does not absorb heat from, or give heat to, a metallic surface as readily as does water. The one advantage of oil is that in case of any leakage inside of the crankcase it mixes with the other lubricating oil and does no damage.

In view of all this, it is readily understood why lubricating oil is used only in special cases where certain conditions make the advantage more than outweigh the disadvantages. For instance, in a high-speed engine such as is used on a naval vessel the engine generally has trunk pistons and a closed crankcase. Here the cooling-oil system can be obtained with the lubricating-oil system and many parts eliminated. There are disadvantages in this, to be sure, but in the cramped quarters of a naval vessel they tend to disappear in the face of the advantages gained.

For commercial work it is safe to say that the choice lies between fresh and salt water. Fresh water requires an

additional system, including tank, pump, cooler and piping, but it is not so corrosive, not so destructive to the packing in the joints of the system, not dangerous as regards deposits in the piston, and in case of leakage into the lubricating oil there is not the danger to bearings. When salt water is used with proper precautions, most of the advantages of fresh water disappear, but it is a question as to how far these precautions can be successfully carried out under every-day working conditions. Both fresh and salt water will undoubtedly be used for some time to come until enough experience is gained with both systems to finally settle the matter either one way or the other, or it may be that fresh water will be used for high-grade installations and salt water where first cost and simplicity are of prime importance.

METHODS FOR COOLING THE PISTON

To carry the liquid to and from the piston there are three general systems, but the details for any one system are varied greatly by the various engine builders or by the same builder on different engines. One system is to combine the cooling with the lubrication system as in Fig. 4, but this, of course, is applicable only in case lubricating oil is used for cooling. The general scheme is to supply the oil to the main bearings, from whence it passes through the hollow crankshaft to the crankpin bearings and up the connecting rods to the wrist pins, thence through pipes or passages in the piston to the head and back again through a pipe or passage to some point near the bottom of the piston, from where it can drain directly into the crankpit. A certain amount of oil leaks out at the bearings and this serves to lubricate them.

A second system is to use jointed swinging pipes, and a third system telescopic pipes. Both inlet and outlet pipes can be and are generally used,

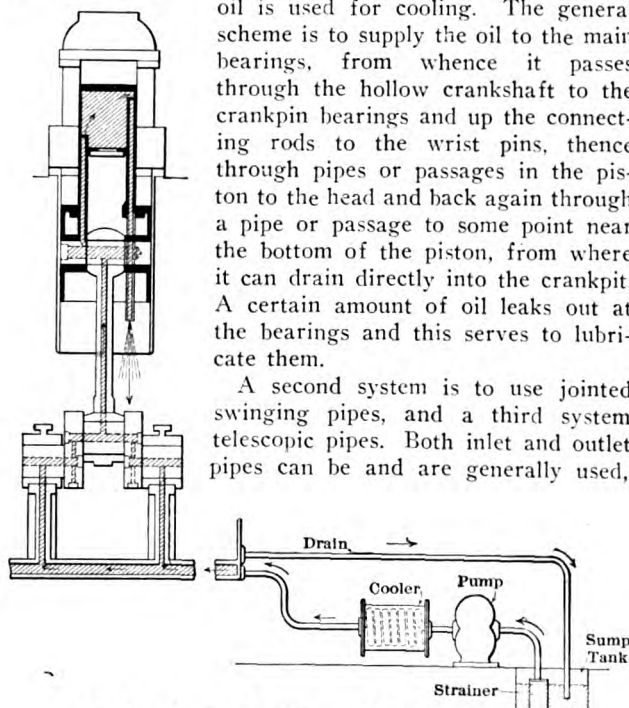


Fig. 4.—Combined Cooling and Lubricating Systems

so that any liquid desired can be employed for the cooling medium. The swinging pipes are suitable for slow-speed engines only, as at high speeds the inertia forces are very large and it is troublesome to take care of them properly. Moreover, the passage for the liquid must by the nature of the case have several bends and turns, and at high revolutions the inertia forces produce extremely high pressures, making it very difficult to keep the joints of the systems tight.

There is one principle that must be followed in the design of swinging pipes for even moderate speeds, and that is to keep the bearings at the joints of the pipes entirely independent of the stuffing boxes, or in other words the piping for carrying the liquid and the strength members for taking the inertia forces must each do its own work, although they are fastened together and are a part of each other. The great trouble with this system is to keep it tight at the joints, and it is only by most careful

design along the lines stated that successful results can be obtained. In case water is used for a cooling medium, the lubrication of the bearings at the joints becomes important, but with forced lubrication there is generally enough oil flying around in the crankcase to take care of this, if pockets, connected to the bearings, are provided for catching it.

Telescopic pipes are adaptable to both high- and low-speed engines. All parts are moving in line with the cylinder axis and taking care of the inertia forces is much simpler than with the swinging links. Moreover, there are fewer turns in the passages for the cooling medium, and, as a general thing, air chambers can be placed so as to effectively care for the surges in the cooling liquids. An air chamber on the suction side is a necessity, but on the discharge side it may be dispensed with, provided the discharge pipes are of generous size. It is good practice

to put an open-end pipe discharging into a funnel, with proper provision against splashing, on the discharge line, so that the cooling fluid coming from the piston can be actually seen by the operator. A certain amount of flexibility in the telescopic pipes is desirable in order to remedy any slight looseness of the piston, or of the crosshead in its guide, or any slight misalignment. One method of accomplishing this is to provide a double pipe—one pipe inside another. The inside pipe is fastened at one end to the piston or crosshead and at the other to the outside pipe. The outside pipe is guided in the part fixed to the engine frame. Here again the most troublesome part is the packing, but it is like packing the piston rod of an engine, and, as might be expected, the most satisfactory packing is of the labyrinth type, with provision for self-adjustment to the pipe, so that it fits snugly under all conditions.

Recent Developments in Shipyard Plants—II

Construction and Capacity of Fitting-Out Cranes—Special Facilities for Building and Installation of Gun Turrets—Shipyard Shops

BY NAVAL CONSTRUCTOR S. M. HENRY, U. S. N.

THE nature of the building slips has been touched on, also the characteristics of the structural shop, and the next item which plays an important rôle in the general scheme of construction is the fitting-out crane, for on its size and ability to handle heavy weights is dependent to a considerable extent the point at which it is desirable to launch and the condition of assembly of machinery and other parts that can be taken care of.

FITTING-OUT CRANE

Compared with the large shipbuilding plants abroad, there is poor equipment for handling heavy weights in this country, whether in private yards or in government establishments. The maximum capacity of any crane in this country at the present time, so far as shipyards are concerned, is 150 tons, and there are few of these, whereas in the big foreign yards there are many cranes of 250 tons capacity. The great cost of this class of equipment has undoubtedly prevented its installation, especially in view of the fact that very large merchant construction has not been undertaken, and it has been possible to get through past naval programmes with available facilities. With the possibilities of larger merchant construction and the growth in the size of naval vessels and of their ordnance, 150-ton cranes are no longer of sufficient capacity, and provision for a materially larger lifting capacity must be made if future naval requirements are to be met.

The heaviest weights required in ship construction are the turrets of battleships. Their weight, stripped of armor and guns, is likely to be in excess of any practicable crane, so that the problem to be faced in determining crane capacity is how great a capacity can be obtained without involving excessive or unreasonable expenditures. All of the Navy's large cranes have so far been of the floating type, the earlier ones of the cantilever construction, and the later of the revolving, luffing type.

An investigation of the possibilities of building floating cranes of materially greater capacity led to the opinion that the cost of such cranes would become prohibitive, and, further, that their great size would be such as to make it practically as difficult to move them as to move the ship

for which the weights are to be handled. This study further led to the view that it was feasible to obtain fixed shore cranes of the revolving, hammerhead type of 350 tons capacity, but that a capacity approaching this could not well be obtained with a traveling crane of any type, and that no other type appeared to compare favorably with the hammerhead type. As a result of this investigation, a crane is now under construction for one of our navy yards having a capacity of main hoist of 350 tons at a radius of 115 feet, and of 50 tons at a radius of 190 feet. In addition to the main hoist, there is an auxiliary hoist of 50 tons capacity. The height of the main hoist above the yard level is 145 feet. The base of the crane is of the portal type, the overall width being 61 feet, with a clear opening of 51 feet, allowing for a double track, standard gage system running through it.

It is proposed to install the crane on the center line of a pier of 100 feet width, giving a clear reach of 65 feet at 350 tons capacity, and 140 feet at 50 tons capacity. The crane will be installed 400 feet from the outer end of the pier 1,000 feet long, the location being based on allowing the handling of weights on any point of a vessel 1,000 feet long, and for giving the most convenient handling of weights for vessels of lesser lengths. So far as we know, this will be the largest crane that has yet been built for the shipbuilding industry. Located as outlined, the crane will give equal service on both sides of the pier, and can take the heaviest loads from barges on one side and place them on board vessels secured on the other side.

TURRET SHOP

One of the serious problems connected with the building of large naval vessels is the completion and installation of the turrets within the period of construction of the vessel. With comparatively limited weight handling facilities, the construction of the turret cannot proceed beyond the assembly of the bare structural work until after the vessel is launched, the heavy structure being handled in separate pieces to be assembled on board the vessel. The large amount of fitting and installing then remaining occupies the entire time until the vessel is completed. A

method of construction which offers much brighter prospects for rapidity, but involves large initial expenditures for equipment, is to build the turrets complete in a shop, to then remove the armor and guns and strip the turrets to a weight that can be handled by the fitting-out crane, and to lift the turrets on board in this condition soon after launching.

With a crane of the capacity described above, this process is entirely feasible, but involves the provision of a turret shop. The work to be done in such a shop is a combination of work such as is done in the structural shop and in the machine shop, and involves very heavy crane service and great height of building. In order to get the maximum benefit of the fitting-out crane, the capacities of the shop cranes should be equal to it, and designs have been prepared for a shop of this type which is to have a height to the under side of roof trusses of 94 feet and span of 100 feet, and to be fitted with two 150-ton bridge cranes, giving a combined capacity of 300 tons. With a shop of this character located on the waterfront, it will be feasible to extend the crane runway over the water a sufficient distance to permit the placing of a turret on a barge, which in turn will deliver it within reach of the fitting-out crane.

Owing to the great height of the completed turret structure, it is necessary either to provide a deep pit for the lower portion of the turret to extend into, or to provide an excessively high roof; or, what appears better, to combine the two methods, which can be done, with a height of 94 feet to the roof trusses and depth of pit of about 16 feet. These dimensions are sufficient to allow the complete assembly of a number of turrets and their removal from the shop as completed. A length of shop of about 60 feet per turret will be required.

Plant developments, such as are described above, are justified only where large construction work is to be carried out. In turn, such construction necessitates the production of large steel forgings and castings and their machining ready for installation. Few of the private yards have been in a position to make their largest iron castings, and practically none to make their steel castings and forgings. The present development of these shops in the navy yard is intended to place them in a position that will enable them to make promptly any repairs that may be needed in war time, with the single exception of heavy ordnance.

FORGE SHOP

In order to make the largest engine and hull forgings, an equipment consisting of a 2,000-ton high-speed steam hydraulic forging press and smaller presses and hammers is required, as well as furnaces and heat-treating equipment necessary in connection with the operation of presses of this size. A building consisting of a main bay 65 feet wide and 67 feet to the under side of roof trusses has been provided for the heavy forging work with two 80-ton cranes. In addition to the main bay, there is being provided a lower bay with 5-ton crane service, and with a height of 29 feet, to take care of the hand fires, etc. In view of the character of the work done in the boiler shop and the size of the crane equipment required for it, it has been considered desirable to combine these two shops in one, for this purpose providing a total length of 700 feet.

An effort has been made in laying out these shops to get away from the old idea that blacksmith or forge shop must necessarily be dirty and poorly lighted without the usual conveniences found in other shops. The type of construction is the same as adopted for the other large shops; that is, steel frame, hollow tile and steel sash sides and Aiken roof. It is intended to provide a wood block floor, except in certain locations of limited area where hot

metal is likely to come in contact with it, in which locations cast plates will be fitted. With a clean floor, ample light and ventilation and oil fuel, it is expected that the working conditions can be made in this shop to approach those found in other yard shops.

FOUNDRY

Provision will be made in the new foundries for the production of all sizes and characters of castings used aboard vessels. The buildings are to have a main bay 80 feet wide and 75 feet to roof trusses with about 80-ton and 15-ton cranes, as well as traveling wall cranes. The side bays are to be 55 and 45 feet wide, the one on the side opposite the cupolas to have a second floor. There will be provision for brass, iron and steel casting, the equipment including both electric and open hearth furnaces, able to make the largest steel castings called for by naval vessels.

MACHINE SHOP

Provision in the machine shops must be made, not only for handling the forgings and castings of the largest size, for which some of the yards are already provided, but also to take care of a much larger volume of work than has been provided for in the past. The larger machine shops now under construction meet the general development under way in the other departments and consist of a main bay, 80 feet wide, with a height of 85 feet to the roof trusses; with a secondary bay, 50 feet wide, with a height of 26 feet to the cranes of 20 tons capacity; and a second floor of the same width, crane capacity of 5 tons, and a height of 18 feet to crane rail. Lean-tos outside of this take care of offices, tool rooms, locker rooms, etc. It is expected that a total length of shop of this section of approximately 1,000 feet will take care of all of the large work. In addition, a machine shop for small work will be provided of the same length with a width of approximately 60 feet and six stories in height.

The outline in the case of the last three shops is very brief and is intended only to give a general idea of the expansion and development found necessary and being made in these departments to conform to the developments under way in the departments that build the hulls.

The growth of many of the minor activities has not been out of proportion to that which we find in the main elements of the yards, and such activities as galvanizing and generation of oxygen, which have in the past been placed anywhere that room could be found for them, have grown to the dignity of independent shops of considerable size, and other activities are still coming on, which give promise of taking a prominent place in shipyard work, the most outstanding of these at the present time being electric welding.

We have to thank the present demand for ships for the progress that has been found possible in the development of the plants. With a continued demand for more and larger ships, it is to be expected that the growth of the plants, which has been begun, will be rounded out so that each department will in its own line be able to compare favorably with the best shops doing a similar character of work in other industries.

Institution of Naval Architects

The annual meeting of the Institution of Naval Architects will be held on April 9, 10 and 11, in the Royal Society of Arts, John street, Adelphi, London, W. C. The Right Honorable The Earl of Durham, K. G., G. C. V. O., P. C., president, will occupy the chair.

The annual dinner will be given on Wednesday, April 9, at 7:30 p. m., in the Grand Hall, Connaught Rooms, Great Queen street, Kingsway, W. C.

LIST OF VESSELS CONTRACTED FOR BY THE
UNITED STATES SHIPPING BOARD
EMERGENCY FLEET CORPORATION

WOODEN SHIPS CONTRACTED FOR

WAYS FOR E.F.C.	COMPANY	DESIGN	D.W.T. PER SHIP	CONTRACTED FOR AND PENDING	
				TOTAL SHIPS	TOTAL TONNAGE
North Atlantic District					
3	Continental S. B. Co.	Own	1,500	1	1,500
4	Cumberland S. B. Co.	Ferris	3,500	9	31,500
5	Foundation Co., The	"	3,500	10	35,000
3	Freeport S. B. Co.	"	3,500	4	14,000
1	Gilcrest, Geo. A.	"	3,500	1	3,500
2	Gildersleeve S. Constr. Co.	"	3,500	2	7,000
6	Groton Iron Works	"	3,500	12	42,000
6	Housatonic S. B. Co., Inc.	"	3,500	6	21,000
3	Johnson Shipyards Corp.	"	3,500	3	10,500
6	Kelley-Speer Co., The	"	3,500	1	3,500
3	Kingston S. B. Co.	"	3,500	7	24,500
3	Russell S. B. Co.	"	3,500	6	21,000
3	Sandy Point S. B. Corp.	"	3,500	2	7,000
12	Shattuck, L. H., Inc.	"	3,500	16	56,000
2	Ship Constr. & Trad. Co.	"	3,500	2	7,000
6	Traylor S. B. Corp.	"	3,500	10	35,000
TOTAL				92	320,000
Middle Atlantic District					
4	Maryland S. B. Co.	Ferris	3,500	6	21,000
4	Missouri B. & I. Co.	"	3,500	7	24,500
2	North Carolina S. B. Co.	"	3,500	4	14,000
4	Smith Henry & Sons Co.	"	3,500	4	14,000
3	Tenney, Chas. H.	"	3,500	4	14,000
4	York River S. B. Corp.	"	3,500	8	28,000
TOTAL				33	115,500
Southern District					
2	Alabama S. B. & D. D. Co.	Ferris	3,500	2	7,000
6	American S. B. Co.	"	3,500	10	35,000
6	Dantzler S. B. & D. D. Co.	"	3,500	6	21,000
4	Dierks Blodgett S. B. Co.	"	3,500	6	21,000
7	Fahey, John H.	Dough'y	5,000	6	30,000
4	Hodge Ship Co., Inc.	Ferris	3,500	8	28,000
4	Jahncke S. B. Co., Inc.	"	3,500	12	42,000
7	M. rey & Thomas	"	3,500	8	28,000
4	Murdock, J. H.	"	3,500	6	21,000
2	Murnan S. B. Corp.	"	3,500	4	14,000
2	National S. B. & D. D. Co.	"	3,500	2	7,000
4	Tampa Dock Co.	"	3,500	8	28,000
4	U. S. Maritime Corp.	"	3,500	9	31,500
TOTAL				95	341,500
Gulf District					
4	Beaumont S. B. & D. D. Co.	Ferris	3,500	12	42,000
4	Heldenfels Brothers	"	3,500	8	28,000
4	Lone Star S. B. Co.	"	3,500	8	28,000
2	McBride & Law	"	3,500	6	21,000
2	McCammon, J. M.	"	3,500	2	7,000
6	Midland Bridge Co.	"	3,500	8	28,000
7	National S. B. Co.	Dough'y	4,700	12	56,400
5	Southern D. D. & S. B. Co.	"	5,000	16	80,000
6	Union Bridge & Constr. Co.	Ferris	3,500	10	35,000
8	Universal S. B. Co.	Dough'ty Ferris	3,500 4,600	6 18	21,000 63,000
TOTAL				112	437,000
Southern Pacific District					
2	Benicia S. B. Corp.	Ferris	3,500	5	17,500
4	Chandler, Ralph J.	"	3,500	6	21,000
4	Coos Bay S. B. Co.	"	3,500	4	14,000
4	Fulton S. B. Co.	Hough Ferris	3,500 3,500	6 4	21,000 14,000
4	Hammond Lumber Co.	Hough	3,500	8	28,000
4	Kruse & Banks S. B. Co.	"	3,500	7	24,500
5	Rolph S. B. Co.	Hough Ferris	3,500 3,500	6 8	21,000 28,000
TOTAL				60	210,000
Northern Pacific District					
2	Allen S. B. Co.	Allen	3,650	3	10,950
2	Babare Bros.	Ferris	3,500	5	17,500
4	Grant Smith-Porter S. Co.	"	3,500	16	56,000
8	Grays Harbor M. S. Corp.	Gr. Harbor	4,000	17	68,000
6	Meacham & Babcock S. B. Co.	"	4,100	8	32,800
3	Nilson & Kelez S. B. Corp.	Ferris	3,500	12	42,000
5	Pacific American Fisheries	"	3,500	8	28,000
3	Patterson-McDonald S. B. Co.	Pac. Amer.	3,500	7	24,500
1	Puget Sound Br. & D. Co.	Pat. McD	4,800	4	19,200
6	Sanderson & Porter	Gr. Harbor	4,000	2	8,000
5	Seaborn Shipyards Co.	Ferris	3,500	15	52,500
4	Sloans Shipyard Corp.	"	3,500	14	49,000
14	Tacoma S. B. Co.	"	3,500	16	56,000
6	Wright Shipyards	"	3,500	10	35,000
3		"	3,500	9	31,500
TOTAL				146	530,950

WAYS FOR E.F.C.	COMPANY	DESIGN	D.W.T. PER SHIP	CONTRACTED FOR AND PENDING	
				TOTAL NO. SHIPS	TOTAL TON- NAGE
4	District No. 11	Ferris	3,500	12	42,000
2	Coast S. B. Co.	"	3,500	2	7,000
8	Feeney & Bremer Co.	Hough	3,500	12	42,000
2	Grant Smith-Porter Ship Co.	Ferris	3,500	22	77,000
2	Kiernan & Kern	Ballin	4,500	4	18,000
6	McEachern Ship Co.	Hough	3,500	10	35,000
4	Peninsula S. B. Co.	Ferris	3,500	10	35,000
4	Rodgers & Co., Geo. F.	Penin.	4,000	12	48,000
4	Sommarstrom S. B. Co.	Ferris	3,500	8	28,000
10	Standifer Constr. Corp. G. M.	Hough	3,500	4	14,000
3	St. Helens S. B. Co.	Ballin	4,500	14	49,000
4	Supple & Ballin	Ferris	3,500	12	54,000
4	Wilson S. B. Co.	Ferris	3,500	6	21,000
TOTAL				146	537,000
Great Lakes District					
	Lake & Ocean Nav. Co.	L. & O.	2,500	1	2,500
GRAND TOTAL				685	2,494,450

WOOD TUGS CONTRACTED FOR

WAYS FOR E.F.C.	COMPANY	DESIGN	CONTRACTED FOR AND PENDING NUMBER
North Atlantic District			
6	Crow inshield S. B. Co.	Ocean	12
4	Cumberland S. B. Co.	Harbor	2
3	Continental S. B. Corp.	Ocean	2
4	Brown & Son, A. C.	Harbor	10
1	Gas Engine & Power Co. and Chas. L.		
4	Seabury & Co., Consol.	Harbor	6
2	International S. B. & Mar. E. Corp.	Harbor	5
2	Sullivan Co., J. W.	Harbor	4
TOTAL			41
Middle Atlantic District			
Bldg. 5	Chance Marine Constr. Co.	Harbor	6
3	Davis & Sons, M. M., Inc.	Ocean	20
2	Eastern Shore S. B. Corp.	Harbor	6
5	Mathis, John H. Co.	Harbor	5
3	Vinyard S. B. Co.	Harbor	3
TOTAL			40
Southern District			
1	Gibbs Gas Engine Co.	Harbor	6
2	Pilkington, George J.	Harbor	2
5	Southland S. S. Co.	Ocean	7
2	Ward & Pride	Harbor	2
TOTAL			17
Southern Pacific District			
Bldg. 4	Main Iron Works	Ocean	7
TOTAL			7
Great Lakes District			
5	Burger Boat Co.	Harbor	6
3	Dachel-Carter Boat Co.	Harbor	5
6	Leathem & Smith T. & W. Co.	Harbor	12
4	McLouth, Sidney C.	Ocean	9
8	Northwest Engr. Works	Ocean	1
3	Universal S. B. Co.	Harbor	16
TOTAL			52
GRAND TOTAL			157
			61
			96
TOTAL			157

WOOD BARGES CONTRACTED FOR

WAYS FOR E.F.C.	COMPANY	D.W.T. PER SHIP	CONTRACTED FOR AND PENDING	
			TOTAL NO. SHIPS	TOTAL TONNAGE
2	North Atlantic			
2	Cobb S. B. Co., Francis	2,500	1	2,500
	Crosby Navigation Co.	2,500	1	2,500
		3,500	1	3,500
1	Green Co., Richard T.	2,500	1	2,500
6	Kelley-Spear Co.	2,500	2	5,000
3	Machin's Ship Constr. Co.	2,500	3	7,500
1	Newcastle S. B. Co., The	2,500	1	2,500
2	Sandy Point S. B. Corp.	2,500	2	5,000
3	Johnson Shipyards Corp.	2,500	2	5,000
		3,500	1	3,500
12	Shattuck, Inc., L. H.	3,500	2	7,000
TOTAL			17	46,500
Middle Atlantic				
5	Coas wise S. B. Co.	2,500	3	7,500
3	Crook Co., H. E.	2,500	2	5,000
2	Whitehaven S. B. Co.	2,500	2	5,000
TOTAL			7	17,500

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WAYS FOR E.F.C.	COMPANY	TYPE	D. W. TONS PER SHIP	CONTRACTED FOR, REQUISITIONED AND CONTRACTS PENDING		WAYS FOR E.F.C.	COMPANY	TYPE	D. W. TONS PER SHIP	CONTRACTED FOR, REQUISITIONED AND CONTRACTS PENDING	
				TOTAL NO. SHIPS	TOTAL TONNAGE					TOTAL NO. SHIPS	TOTAL TONNAGE
	<i>Northern Pacific District (Cont.)</i>						<i>Recapitulation</i>				
5	Ames S. B. & D. D. Co.	Tanker	9,000	2	18,000		North Atlantic.....			287	1,920,730
4	Columbia River S. B. Corp.	Cargo	8,800	32	281,600		Middle Atlantic.....			113	1,053,560
4	Duthie & Co., J. F.	"	8,800	27	237,600		Delaware River.....			170	1,463,377
4	Northwest Steel Co.	"	8,800	41	360,800		Delaware River Agencies.....			240	1,925,000
5	Seattle Constr. & D. D. Co.	"	7,500	21	157,500		Southern.....			86	623,300
5	Seattle Nor. Pac. S. B. Co.	"	10,500	1	10,500		Southern Pacific.....			235	2,147,000
5	Skinner & Eddy Corp.	"	9,400	10	94,000		Northern Pacific.....			307	2,609,994
	"	"	8,694	1	8,694		Great Lakes.....			445	1,683,250
	"	"	8,800	30	264,000		ENTIRE COUNTRY.....			1,883	13,426,211
	"	"	9,600	58	556,800						
	"	"	9,000	1	9,000		Japan.....			45	374,456
5	Standifer, G. M. Constr. Corp.	Tanker	9,500	15	142,500		China.....			4	40,000
7	Todd D. D. & Constr. Corp.	Cargo	7,500	24	180,000						
	TOTAL.....			307	2,609,994		GRAND TOTAL.....			1,932	13,840,667
	<i>Great Lakes District</i>						<i>Resume of All Steel Ships</i>				
3	American S. B. Co., The	Cargo	3,550	5	17,750		Under 5,000 D. W. Tons.....			510	1,938,322
	(Buffalo Plant).....	"	4,200	3	12,600		5,000 to 5,999 D. W. Tons.....			215	1,095,625
	"	"	4,050	3	12,150		6,000 to 7,499 D. W. Tons.....			84	573,980
6	(Chicago Plant).....	"	3,100	4	12,400		7,500 to 8,500 D. W. Tons.....			271	2,079,790
	"	"	3,550	9	31,950		8,501 to 9,999 D. W. Tons.....			664	6,038,717
	"	"	4,050	7	28,350		10,000 and over D. W. Tons.....			188	2,114,233
	"	"	4,200	7	29,400		TOTAL.....			1,932	13,840,667
3	(Cleveland Plant).....	"	3,100	4	12,400		Tugs No. D. W. Tons.....			112	16,000
	"	"	3,550	10	35,500		Barges 2,000 D. W. Tons.....			8	15,000
	"	"	4,050	6	24,300		7,500 D. W. Tons.....			2	
	"	"	4,200	6	25,200		TOTAL.....			122	31,000
10	(Detroit Plant).....	"	3,100	10	31,000		GRAND TOTAL.....			2,054	13,871,667
	"	"	3,550	15	53,250						
	"	"	4,050	24	97,200						
	"	"	4,100	2	8,200						
	"	"	4,200	20	84,000						
8	(Lorain Plant).....	"	3,100	9	27,900						
	"	"	3,550	11	39,050						
	"	"	4,050	14	56,700						
	"	"	4,200	18	75,600						
5	(Superior Plant).....	"	3,100	4	12,400						
	"	"	3,550	6	21,300						
	"	"	4,050	6	24,300						
	"	"	4,200	6	25,200						
5	Globe S. B. Co.	"	3,500	10	35,000						
	"	"	4,050	10	40,500						
	"	"	4,200	15	49,500						
8	Great Lakes Engr. Works	"	3,350	4	13,400						
	(Ecorse Plant).....	"	3,400	1	3,400						
	"	"	4,000	2	8,000						
	"	"	4,050	16	64,800						
	"	"	4,200	17	71,400						
	"	"	5,500	2	11,000						
3	(Ashtabula Plant).....	"	3,300	8	26,400						
	"	"	3,350	2	6,700						
	"	"	4,000	2	8,000						
	"	"	4,050	8	32,400						
	"	"	4,200	7	29,400						
6	Manitowoc S. B. Co.	"	3,400	14	47,600						
	"	"	3,500	8	28,000						
	"	"	4,050	18	72,900						
9	McDougall-Duluth Co.	"	3,100	7	21,700						
	"	"	3,300	2	6,600						
	"	"	3,500	10	35,000						
	"	"	4,050	15	60,750						
4	Saginaw S. B. Co.	"	3,500	12	42,000						
	"	"	4,050	12	48,600						
6	Toledo S. B. Co.	"	2,930	10	29,300						
	"	"	3,500	8	28,000						
	"	"	4,050	16	64,800						
	TOTAL.....			445	1,683,250						
	<i>Japan Contracts</i>										
	Asahi.....	Cargo	5,500	1	5,500						
	Fujinigata.....	"	6,300	1	6,300						
	Harima Co.....	"	5,000	1	5,000						
	Ishikawajima.....	"	10,500	1	10,500						
	Kawasaki.....	"	5,000	2	10,000						
	Nitta.....	"	9,000	5	45,000						
	Yokohama.....	"	5,500	1	5,500						
	Asano.....	"	6,300	3	18,900						
	"	"	12,600	2	25,200						
	<i>Japan Contracts</i>										
	Uraga.....	Cargo	6,650	3	19,950						
	Mitsue Bussan.....	"	9,100	2	18,200						
	Mitsubishi.....	"	8,400	2	16,800						
	Uchiba.....	"	8,500	2	17,000						
	Osaka.....	"	10,500	4	42,000						
	TOTAL.....			30	245,850						
	<i>Japan Purchased</i>										
	Kawasaki.....	Cargo	9,000	2	18,000						
	"	"	9,103	1	9,103						
	"	"	9,027	1	9,027						
	"	"	9,066	1	9,066						
	"	"	9,062	1	9,062						
	"	"	9,070	1	9,070						
	Uraga.....	"	6,771	1	6,771						
	Suzuki.....	"	5,000	1	5,000						
	"	"	6,775	1	6,775						
	"	"	10,705	1	10,705						
	Asaha.....	"	11,033	1	11,033						
	Suzuki.....	"	6,695	1	6,695						
	Nippon Kisen Kashi.....	"	6,699	1	6,699						
	Kuhara.....	"	11,600	1	11,600						
	Asano.....	"									
	TOTAL.....			15	128,696						
	<i>China</i>										
	Kiangnan Dock & Eng. Wks....	Cargo	10,000	4	40,000						

STEEL TUGS CONTRACTED FOR AND CONTRACTS PENDING

4	North Atlantic District										
Bldg. 4	Bayles Shipyard, Inc.	Ocean	A	8	A						
	Bethlehem S. B. Corp., Ltd.	"	A	30	A						
	Gahagan, W. H., Inc.	"	A	10	A						
1	Gas Engine & Power Co., (Chas. L. Seabury Consd.)	"	A	3	A						
4	Newburgh Shipyards, Inc.	"	A	3	A						
2	New Jersey D. D. & Trans. Co.	"	A	2	A						
5	Providence Engr. Corp.	"	A	10	A						
	TOTAL.....			66	A						
Bldg. 4	Southern District										
	Johnson Iron Works, Ltd.	Harbor	A	6	A						
Bldg. 3	Great Lakes District										
2	Foundation Co., The	Ocean	A	10	A						
8	Lake & Ocean S. B. Co.	"	A	3	A						
	Northwest Engr. Works	"	A	15	A						
4	Whitney Bros. Co.	Harbor	A	2	A						
	TOTAL.....	Ocean	A	40	A						
	ENTIRE COUNTRY...	Harbor	A	104	A						
	GRAND TOTAL.....			112	A						

STEEL BARGES CONTRACTED FOR AND CONTRACTS PENDING

1	Southern District										
Bldg. 2	Alabama D. D. & S. B. Co.	Canal	7,500	2	15,000						
	Nashville Bridge Co.	Oil	2,000	8	16,000						
	TOTAL.....			10	31,000						

CONCRETE SHIPS CONTRACTED FOR

1	North Atlantic District										
	Fouger Amer. S. Con. S. B. Co.	Cargo	3,500	1	3,500						
Bldg. 2	Middle Atlantic District										
	Liberty S. B. Co.	Cargo	3,500	2	7,000						
	TOTAL.....	Tanker	7,500	2	15,000						
				4	22,000						
Bldg. 2	Southern District										
	Bentley & Sons Co., The A.	Tanker	7,500	4	30,000						
1	Liberty S. B. Co.	Cargo	3,000	1	3,000						
1	Ley & Co., Inc., Fred T.	Tanker	7,500	4	30,000						
	TOTAL.....			9	63,000						
3	Southern Pacific District										
1	San Francisco S. B. Co.	Tanker	7,500	4	30,000						
	Pacific Mar. & Constr. Co.	"	7,500	4	30,000						
	TOTAL.....			8	60,000						
	GRAND TOTAL.....			22	148,500						

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

A Piston Repair

While on watch one day after going the rounds of the engine room to see that all was right, I was greatly surprised to hear a knock on one of the donkey pumps. The pump was immediately stopped and a thorough inspection made. I could find nothing wrong with the external gear, so the cylinder cover was removed, when it was seen that a piece of the piston was broken off, the fracture extending across the top of the piston about 4 inches and down the body of the piston to about $1\frac{1}{4}$ inches below the groove for the piston ring. It was a lucky thing for us that the fractured part happened to be on the side opposite the steam port, for there is no saying what might have happened if it had been on the same side.

As we had about a week's voyage before we reached our home port, it was deemed advisable to make the repairs as soon as possible, since it is a well-known fact that donkey pumps sometimes move only when it suits themselves.

The fracture of the piston was repaired in the following manner: Two $11/16$ -inch holes were drilled on the top side of the broken piece and three $11/16$ -inch holes on the body part. The broken piece was then replaced and the holes marked off on the piston proper. These holes were then drilled for $5/8$ -inch taps, after which studs were screwed in and the fractured piece riveted on, the holes in the broken piece having previously been countersunk so as to make a good tight job.

The piston was put in the lathe and its diameter reduced from 7 inches to $6\frac{5}{8}$ inches, thus eradicating the grooves for the piston rings. A piece of plate $5/8$ -inch thick was then procured and cut to the depth of the piston. The two ends of the plate were scarfed down by means of a hammer and chisel and finished off with a file. The plate was then placed in the furnace fire and heated up to a welding heat, the scarfed ends being hammered together to make a good joint. This operation required three heats to make a good job, owing to the lack of sufficient tools to do the work (the usual thing at sea). However, we were glad to feel that we had been successful.

The plate was finally subjected to another heat—this time just red—and while at this temperature it was carefully shrunk onto the piston and allowed to cool. When the plate was sufficiently cool we proceeded to drill a number of $5/8$ -inch tapping holes right through the liner and into the body of the piston for a depth of $3/4$ inch. The holes were then tapped and the studs screwed in, the holes in the liner being previously countersunk for riveting. In marking off the holes, great care was taken that they should not fall where the piston ring grooves were to be cut or where the holes would come in contact with the fractured part.

After all the riveting was finished the plate was put into the lathe and reduced to its working size (7 inches). The grooves were then cut and new rings fitted. To make sure that no steam would pass up or down between the liner and the piston, both ends were calked. Finally the

piston rod was put in place, the nut screwed up and then the piston was put into the cylinder and coupled onto the connecting rod.

When the pump was started, to everyone's joy the job proved most satisfactory; in fact we never had any more trouble with it.

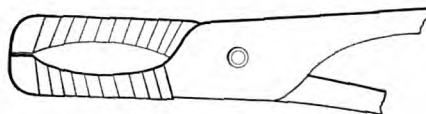
Sydney, N. S. W.

A. LANG.

Tool for Handling Grease Cups and Other Polished Piping

Considerable time is frequently wasted in removing and replacing brass grease cups because of the care taken to prevent the scratching or scarring of the soft, polished brass parts with the ordinary steel jaw pliers or wrenches. To avoid this the writer hit on the scheme of making up a set of special pliers to handle this brass work.

The jaws of a pair of Utica gas pliers were ground out



Special Pliers for Handling Brass Work

smooth to the shape shown in the sketch and then covered with a thick wrapping of electric tape. When this tape wrapping hardened it offered an excellent grip on the brass without scarring or cutting it.

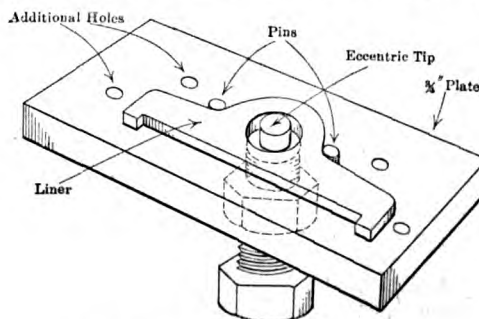
This little scheme worked out so satisfactorily that several other similar pliers were made up, including a tape-protected wrench, for handling highly polished oil and other brass piping.

Philadelphia, Pa.

W. A. LAILER.

Liner Filing Vise

On board ship there are a large number of small bearings that require frequent adjustment, and all of these bearings are fitted with liners or shims, and sometimes it is necessary to thin down some of the thick liners. The



Vise for Holding Liners When Filing

vise shown in the sketch is a very useful affair for gripping such liners when filing them down.

It consists of a piece of $3/4$ -inch plate with a hole drilled and tapped to receive the bolt shown at A. The tip of this bolt is turned eccentric, and this tip, when the bolt is

turned, will force the liner against the two pins indicated, thus clamping it. Additional holes permit the pins to be shifted to suit other style liners.

MACHINIST.

Two Note Book Kinks

Clip these two sketches out and paste them in your note book; then sometime when you come across an old carpenter's ratchet brace convert it into a handy small ratchet drill by cutting off the handle at the place shown in the

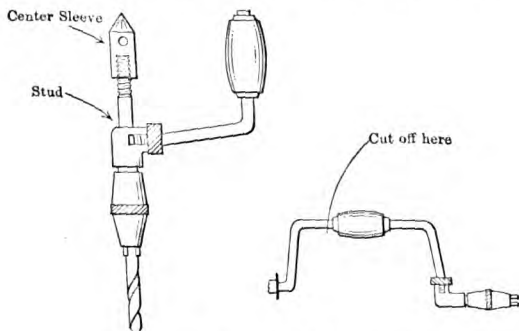


Fig. 1.—Improvised Ratchet Drill

small view and then putting a small $\frac{3}{8}$ -inch stud in the back end of the chuck or brace head as indicated. Make a center sleeve for feeding the ratchet, and the tool is ready for use.

Most all sea-going men to-day use safety razors, therefore there must be lots of discarded safety razor blades

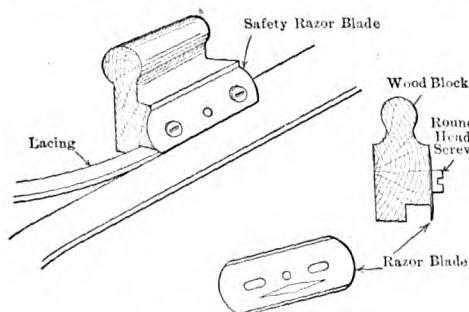


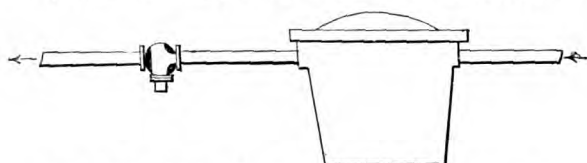
Fig. 2.—Belt Lace Cutter

about the washroom shelves. Pick them up and save them; there are many good uses for them. One is shown in the sketch Fig. 2—a belt lace cutter. This sketch needs no description, other than saying that the blade is secured through the holes in it by small round-head screws.

ASSISTANT.

Tell-Tale on Steam Trap

Where a number of traps are discharging into a returns or sump tank it is very difficult to be able to detect when



Three-Way Valve Used as Tell-Tale on Steam Trap

the traps are leaky or which particular traps require attention. In order to provide a check or tell-tale for each trap, we secured some three-way valves and installed

them on the outlet of each of our traps. Ordinarily the three-way valve was placed so that the trap discharge blew through to the receiving tank as ordinarily, the bypass pipe being shut off by the blanked side of the valve. However, when we desired to check how the trap was working, or whether it was leaking, the three-way valve was turned to divert the steam through a bypass connection to the atmosphere. When thus by-passed, we could observe the action of the trap, determine the quantity of water it discharged, whether it shut off promptly or whether it constantly leaked steam, etc.

W. A. L.

Sounding Rod for Double Bottoms

The type of sounding rod or stick used on board most steamships for sounding the depth of water in bilges and double bottom compartments is nothing more than a rod of steel graduated in inches over which is rubbed a little chalk. Dropping this into the sounding tube, the water wets the rod thus marking on the chalk the indicated depth. This rod is fairly satisfactory, but it has some faults, among which are the following:

When the rod is put into the tube it sometimes gets wet from moisture in the tube, or the chalk gets rubbed off in dropping the rod down through a long tube such as one of the sounding tubes from the upper decks to the bilges. Sometimes there is not a piece of chalk to be found.

To avoid these troubles and to get an accurate sounding of the double bottom, I have adopted a sounding rod such as shown in Fig. 1. It is a home-made affair made out of a piece of half-inch brass pipe split in half lengthwise. At intervals of one inch a small slot is cut the width of a hacksaw blade; into

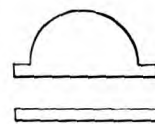


Fig. 2
Improvised Sounding Rod

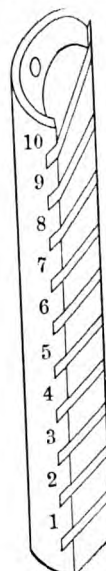


Fig. 1

these slots small steps, made as shown in Fig. 2, are placed and soldered. The slots are cut at an angle of about 45 degrees and just deep enough to take the shoulder of the brass step. Small pockets are formed in the completed rod. When the rod is dropped into the tube for a sounding, the water or liquid is accurately measured by the filled pockets.

To make this type of rod requires patience, but the oiler or the water-tender who has to sound the reserve feed every watch will surely appreciate having one.

OILER.

Cleaning Water Sides of Babcock & Wilcox Boilers

Since a great many ships are equipped with Babcock & Wilcox boilers, no doubt the methods used to clean the water sides of these boilers would be of some interest to all engineers, for we all have ideas of our own which we get by experience.

In the plant under my care there are sixteen Babcock & Wilcox watertube single-drum boilers of the 27 header type with cross-boxes at the front. We cannot lay down a definite cleaning schedule, due to the various demands made upon the plant for different speeds and sailing orders. However, we try to clean each boiler as regularly

as possible and within a radius of 1,200 steaming hours. If the make-up of the feed water used is clean or free from solids, this period is just about right; but when water is used, unavoidably, that contains fouling matter, or salt feed, oil, grease, etc., the boilers should be examined oftener for safety. To do this it is only necessary to open a few scattered handhole plates and one manhole plate. Often this reveals a condition that is not expected. Many times this small inspection has enabled us to keep the boiler in service longer than 1,200 hours. When a general inspection, as referred to above, is made you can determine the kind of deposit that is present. If it is soft and not of a scale-forming nature, a good washing out under 75 to 100 pounds pressure will take most of this off and the boilers are in condition to steam longer.

When a condition such as above is found, we send two men into the steam drum with a fire hose. The hose has a nozzle opening of 2 inches, with handles, so that it can be held in the tubes. When the pressure is going through it, we take off the bottom front row of handhole plates, so that the water has plenty of outlet. The hose with pressure is put in the end of each circulating tube in the steam drum and kept there for at least four or five minutes; then each header is washed down through the nipples. The hose is then put into the bottom of each 4-inch tube at the front end where the plate is off; they have previously been cleaned by running a brush through them once. This row of tubes is directly over the fire, and, since the tubes are large, it is necessary to take the plate off these to aid the washing out process. We always clean these tubes thoroughly. After washing, all plates are carefully replaced and the boilers are ready. The whole operation of opening these few plates, washing and closing the tubes, can be accomplished in a few hours, the actual time being six hours for four boilers, the work on each progressing in conjunction with the others. These inspections save time, labor, boiler gaskets, etc., and also give more boiler service with a feeling of safety. No boiler that is known to have deposits or fouling on the heating surface of its water sides is in a safe condition for steaming. This is often the cause of overheating.

When the boilers are to be thoroughly cleaned, they are taken out of the line, and when the stop valves are secured we introduce 25 pounds of boiler compound in solution into the steam drum. While the fires are dying the water is circulated by an auxiliary feed pump taking a suction from the bottom blow-down valve and feeding it back into the steam space. This does very good work, and it will be found that when you open the boiler the sediment dries very readily and is easy to remove. When the fires are dead and the boiler water cooled to about 175 degrees, the bottom front upright or leg plates are kicked in with a long bar, and the water and scum emptied into the bilge. All front header plates are rapidly taken off, also leg and crossbox plates, and the lower row of plates in the back headers.

We generally work the cleaning of at least four boilers together; and as the saving of time in cleaning or laying up of a boiler is always urgent in this plant, we plan to have all cleaning tools, such as brushes, scrapers and air tools, in condition to expedite the work. As soon as the first plate is taken off, the actual work of cleaning is begun—320 hand-hole plates to each boiler are cleaned, the threads of the studs oiled, the nuts made to go on easy, etc. This is all done by four men in three days of eight hours, or in three watches (we always work the cleaning in watches).

If the sediment on the inside of the tubes is dry, the punching of them with spiral wire tube brushes is im-

mediately begun. There are 902 two-inch tubes and 57 four-inch tubes to a boiler. The cleaning brushes are passed through each one twice. Working two brushes to a boiler, it takes twenty hours. One man is in each steam drum punching the circulating tubes, down-take nipples and scraping the shell. As fast as the tubes of one header are cleaned a man follows with brushes and scrapers, cleaning the seats for the new gaskets. During the progress of cleaning, the boiler is inspected by the engineer for structural defects, the firesides are cleaned and the fire tiles examined—in fact, the whole boiler setting is given attention. When the dirt or sediment shows a tendency to be troublesome in removing, we use brushes on a rod in a reversible air motor—just the common spiral wire tube brush, secured in a piece of rod. This wears the brushes out much sooner than hand punching; but even when worn they do good work, for they will always run out of true, so that they touch all around the tube. At the completion of the cleaning with brushes, the loose dirt is blown out with air, the whole boiler washed out with a 60-pound pressure of water, and immediately closed and filled with hot water to prevent rusting. This softens the gaskets and they can be set up tighter. The average length of time required to complete this method of cleaning is thirty-six hours for four boilers.

Concord, N. H.

C. H. WILLEY.

Waste Heat Utilization

The method of obtaining fresh water for marine purposes, proposed by Mr. Cole Newman in the December issue, is a rather remarkable proposition. The writer seems blessed with a vivid imagination untempered by any practical considerations whatsoever. If the article is serious, the mind of the writer is apart from rational perspective; to the marine engineer conversant with the problems involved, the idea of obtaining water from smoke is as visionary as the proposed raw material.

Production of CO_2 from the products of combustion in a boiler is a well-known process practiced for the purpose of obtaining a refrigerant media. The plant involved is, however, very considerable, and on a ship would occupy more space than the existing total power equipment. The writer has been privileged with unrestricted access to one of the largest plants in England making CO_2 as a commercial venture. The plant for the recovery of the moisture in the combustion products of boilers would occupy at least equal space.

Like others who have mentioned sea water distillation in these pages, reference is made in the article to the problem of salt incrustation in distilling apparatus using sea water. Such a belief is based on misconception and is at variance with fact. The present writer, from practical experience with evaporative plants at sea and extended tests of land installations, is in a position to state that the deposit of incrustation met with due to such evaporation is the limy deposit known as boiler scale; *salt, as such, does not deposit unless the plant is mis-managed.*

Salt water feed in Scotch boilers does not lead to the deposition of salt, provided always that the man responsible knows the elementary facts concerning the use of salinometer and fractional blow-down. Distillation compares equally and exactly and is subject to the same practice, the rule being never to exceed $3/32$ density. What actually happens is concentration of the original sea water into denser brine. Total evaporation would, of course, crystallize out the salt, but until the saturation point is reached there is no tendency to do this. The matter can

be proved by a simple experiment by either making up a solution from known ingredients or evaporating away given amounts of sea water.

The usual practical assumption is that under boiler conditions actual salt does not deposit until a density of $7/32$ is reached. Incrustation is heavy, of the usual lime magnesite type, since the whole of this contained in the water is precipitated.

This point is dealt with because in recent conversations with competent engineers unacquainted with the special problems involved in distillation of sea water on a large scale, they all assumed that deposition of salt was the main drawback. The present writer, in common with thousands of others, has had practical experience in the use of salt makeup feed with Scotch boilers and triple-expansion engines, the addition of small quantities subject to limits of total density being operative for months on end. Total salt water feed was at one time usual when boiler pressures were lower, but, although incrustation is heavy in a case of this kind, salt does not deposit. An external leak will show ropes of salt due to total evaporation, but this external boiling-off is not indicative of similar conditions internally.

Salt water distillation is comparable in all respects with total salt water boiler feed; the density is held below $3/32$ by the salinometer test, a fractional proportion of the contents of the evaporator being continuously run to waste through blow-down. Those unacquainted with this matter of continuous fractional blow-down in marine boilers are advised to consult any good marine text book which treats the matter fully.

Returning to the proposals ventilated by Mr. Newman, potable water made in a modern distillation plant from sea water is unusually pure even under the most delicate nitrate of silver test. The process is simple, direct and well known, the plant occupies small space, and in competent hands involves very little trouble. A quadruple effect plant has, under the writer's supervision, given 33 pounds of fresh water produced for one pound of Welsh coal burned; this was a new plant under very exacting test conditions. Moreover, the moisture, which forms a very insignificant portion of the products of combustion, involves the treatment of the whole of these through apparatus of very large size, the resultant, when and if obtained, would be so foul and so impure that rectification would still involve distillation. Sea water is at least clean when heated, it does not give off tainted odors to contaminate the distillate, and to recover at infinite cost an inferior raw material with the whole ocean oversight is simple folly. In spite, therefore, of spoiling the boiler draft, impairing combustion of the original fuel, making larger boiler power essential and the provision of a large after treatment plant necessary, the resultant would be an unpleasant fluid needing still the usual process to rectify. "Looping the loop" in this wise is pure absurdity.

In the case of an internal combustion engine, freedom of exhaust is very necessary, and to impair this to recover the moisture present is equally uneconomic and absurd.

The present writer has two recollections of interest to relate. The first concerns a case where he was called into consultation relative to using the exhaust heat from a number of large gas engines. It was required to heat a definite amount of water a given temperature, and the joke was that to do this would require more than half the thermal value of the total gas used as fuel in the engines. Someone, struck by the fact that the exhaust products were obviously hot, thought that there was a great waste of heat and proposed to install a heater to use it up.

The amount of unexpended heat in an internal com-

bustion engine is by no means great. The original thermal content of the fuel has had the major portion already utilized as power. The more economical the engine, the less the inevitable wastage.

The second case concerns an experimental test to use the same source of heat through the combustion chamber of a locomotive boiler, in this instance with the intention of subsequent distillation. A rather bad exhaust backfire shifted the boiler bodily and the experiments were abandoned.

At the same time the exhaust heat of a large oil-propelling set might conceivably by special arrangement serve the purpose of fresh water supply. Provided that the engines were of considerable size and the distilling requirements small, the problem might meet satisfactory solution.

Preheating the fuel oil by means of the exhaust pipe heat is common enough; it gives fluidity to very viscous fuels. In the same manner the preheated jacket water used as feed, surrounding the exhaust pipe by suitable means, might evaporate small quantities of steam for subsequent condensation. This would allow free exhaust to the engines and give a source of heat available and hitherto wasted. Fractional blow-down would have to be practiced, if the water be salt.

There is a certain feasibility in the project so outlined, and expectations as to the quantity of distillate must be extremely conservative. Assuming that 10 percent of the total thermal value of the original fuel escapes to the atmosphere and that one-third of this can be recovered, taking a consumption of .5 pound per horsepower hour and a value of 20,000 B.t.u. per pound, 300 pounds of water evaporated per hour from 1,000 horsepower is the result. It would be safe to assume a further one-third loss of, say, 20 gallons per hour as a likely result. In continuous operation this means 480 gallons per day. The temperature of the exhaust is assumed to be sufficiently high to evaporate water into steam, and the entire figuring is based upon unproven assumptions.

In this connection, feed heaters based upon funnel temperature and dependent upon using the waste heat of the products of combustion from boilers are commonplace in land power plants. Due probably to constructional difficulties they have never met with much favor in marine connections, so that utilization of internal combustion engine exhaust heat may not be practical politics upon trial.

The subject of utilizing waste heat by apparatus designed to that end is very interesting; the best use that has yet been made in the case of steam plants is to heat feed water. Still in a condensing engine it is questionable whether utilizing the exhaust steam and impairing the vacuum is worth while; anything interposed, which hampers free exhaust, minimizes power.

So weird a project as that of Mr. Newman is certainly impracticable. It is the fruit of vivid imagination wedded to practical inexperience without logical reflection as to the problems involved.

London.

A. L. HAAS.

Firemen Wanted on Merchant Ships

The United States Shipping Board wants 1,500 husky young Americans at once to learn the business of firing boilers on the new ships of the merchant marine. The men accepted will be placed on training ships at \$30 a month training pay for thirty days, and will then be sent on deep-water voyages at \$75 a month. Uniform and board are furnished. Discharged soldiers and naval reservists are eligible for this work. Other young men of good physique and habits, weighing 140 pounds or more, will also be accepted.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY "NAVAL ARCHITECT"

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

There will appear in this column from time to time questions which have been asked by the Board of Steamboat Inspectors in the various examinations for engineers' licenses conducted by them. Such questions will be denoted by an asterisk (*) placed before the number if from examination for grade of chief, and by a dagger (†) if from examination for other grades.

Water Level in Gage Glass and in Boiler

Q. (996).—Does the water column on a boiler show the true water level? How much higher is the water in the boiler than in the glass?

A. (996).—The gage glass does not show the true level of water in the boiler. This is due to several causes. The chief one is that the density of the water is not the same in the boiler as in the glass, due to difference in temperature and freshness. Again, if the upper branch of the water column is near a steam outlet, this will be sure to affect the water level. Water in the gage glass will be cooler than that in the boiler, which makes the former denser, or the difference in temperature will cause the level to be lower in the gage glass than in the boiler. The amount of this difference in level will depend upon the length of gage glass.

Piston Ring Design

Q. (997).—Will you kindly give me the following information regarding the machining of piston rings of a main engine: Size of casting from which rings must be made. How to determine the first rough machining? Amount to be cut off; kind of cut and kind of cod piece to be used? Machining to finished dimension after cut? Clearance necessary after ring is set in the cylinder bore? Suggest the best way of cutting water grooves, and if these are absolutely necessary? If springs on the back of these, what pressure would you allow? Would steam pressure be better? The conditions I am dealing with are shown in Figs. 1 and 2.

A. (997).—Unfortunately the sketches do not show the diameter of the cylinders or pistons. We may, however, assume that these are 28 inches by 45 inches by 72 inches. Your sections would indicate that a Cameron packing ring

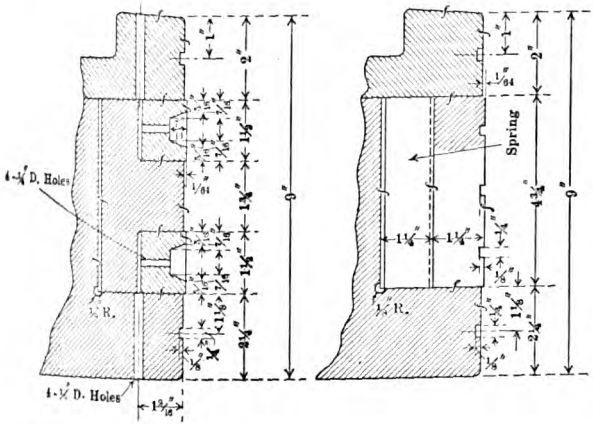


Fig. 1.—Piston Ring for High and Intermediate Pressure Cylinders

Fig. 2.—Piston Ring for Low Pressure Cylinder

was to be used for the low pressure cylinder, and for the intermediate and high pressure two rings of uniform section which depend on the natural spring of the ring to force them out against the cylinder walls. Seaton advises that piston rings be designed so that they exert a pressure of $3\frac{1}{2}$, 3 and $2\frac{1}{2}$ pounds per square inch of ring surface respectively for the high, intermediate and low pressure cylinders.

The construction of the rings for the high and intermediate pressure cylinders (Fig. 1) is unusual. The bearing surface of each of these two rings upon the cylinder walls is rather small, since the effective depth is only $\frac{5}{8}$ inch. Furthermore, it is probable that the $\frac{1}{8}$ -inch and $\frac{1}{4}$ -inch diameter holes which admit steam to the

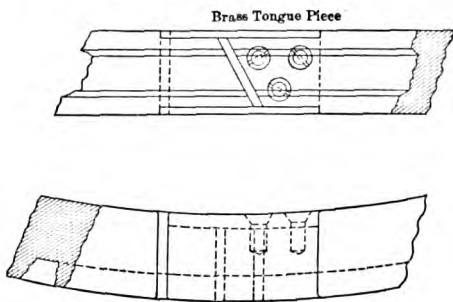


Fig. 3

back and to the front of the rings would be likely to clog with dirt or grease. Although the old method of using coach springs has several disadvantages, it is often employed for intermediate and low pressure cylinders. The high pressure piston may have Ramsbottom rings, spring rings and coach springs or be simply a plug piston machined so as to have about .005-inch clearance.

Piston rings for an engine of this size may be cast to turn up $\frac{3}{4}$ inch, $\frac{7}{16}$ inch and $\frac{5}{16}$ inch larger than the diameter of the cylinders. Cut out a piece of the ring so that it will be slightly shorter than the circumference of the cylinder and allow for the ring's expansion. Then clamp the ring on the face plate of a lathe for the finishing cut, making it from $\frac{1}{16}$ inch to $\frac{1}{8}$ inch greater in diameter than the cylinder.

Fig. 3 shows a very simple means of preventing leakage by the ends of ring. Water grooves are advisable for two principal reasons—they cut down the leakage by the piston springs, and also aid in lubricating.

The dimensions shown in Figs. 1 and 2 are reasonable. There is probably no detail of marine engine design which is more open to discussion and experiment than the proper type of piston rings.

Yacht Design

Q. (998).—What books would you recommend as an aid in yacht and sailing vessel design?

A. (998).—Several very good books have been written on the design of sail yachts. "Elements of Yacht Design," by Norman L. Skene, covers the theoretical side of the subject. For racing yachts the minimum scantlings are often determined by the rules of the class for which they are designed.

To my knowledge, there is no publication which treats entirely upon the design of sailing vessels. If of large size, their scantlings will be determined by the rules of the insurance society. The amount of sail area, size of spars, etc., may be based upon some previous design which has proved satisfactory. Any good text book on naval architecture will cover the displacement and stability as well as the powering in the case of an auxiliary vessel.

Development of a Flanged Bracket

Q. (1,000).—Kindly outline a method of developing brackets connecting shell longitudinals with bulkhead stiffeners (Isherwood system), where the shell has double curvature.

A. (1,000).—It should be remarked that the construction suggested here, namely, using the stiffener bracket to serve also as stringer bracket, is not always followed. Figs. 1 and 2 illustrate the construction in question. Since

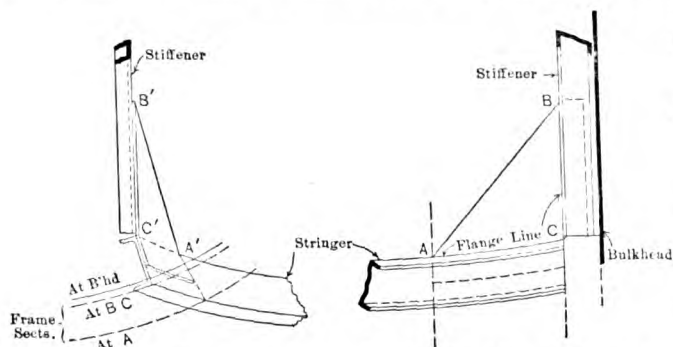
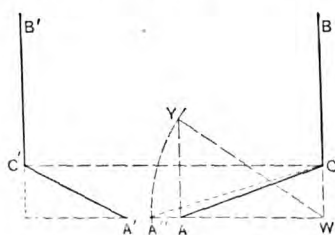


Fig. 1.—End View of Bracket

Fig. 2.—Side View of Bracket

the bracket must be flanged where it attaches to stiffener and stringer, these flange lines will be AC and BC . A template of the bracket can now be readily made on which the flange lines, angle to flange to, landing, and type of riveting to both stiffener and stringer are shown. Holes on one arm of the bracket may be left blank, if desired, until erection. The true shape of the bracket can be

End Projection. Side Projection
Fig. 3

found by obtaining the length of the sides of the triangle ABC . Side BC projects in its true length. The true length of the side AC may be obtained as follows: Draw AY (Fig. 3) perpendicular to $A'W$ and equal to $A'X$ in length; lay off from W the distance WA'' equal to YW ; then $A''C$ is the true length of side AC . In like manner the true length of AB can be found.

Cost of Vessel's Hull and Machinery

Q. (999).—Will you kindly inform me as to the relative cost of hull compared with the machinery of a vessel. Hull to include the steel hull, fittings, houses and furnishings, cargo gear; the machinery to include the propelling machinery, engine room auxiliaries and all piping. Of the above machinery cost, how much would be spent for auxiliaries, etc., purchased outside the shipyard?

A. (999).—The relative cost of machinery to hull of vessels depends upon several considerations, viz., type of machinery—reciprocating, turbine or Diesel engine—speed and size of vessel, etc. A fast vessel will require carefully designed and constructed machinery, which will add

not a little to the cost; likewise, the machinery weight of a small ship will be greater in proportion to the displacement than that of a large vessel, provided the speed is the same in both instances.

For a cargo ship about 400 feet long and with reciprocating engines and Scotch boilers, the following are pre-war figures: Hull, \$395,000; machinery, \$155,000.

Practice varies in different American shipyards as to what amount of the machinery shall be constructed in the yard. Some companies will even undertake the manufacture of such auxiliaries as the pumps, windlass and steering gear. Should we decide that only the main engines, boilers and condenser be built at the yard, and that all auxiliaries, both engine room and deck, be bought from the manufacturers of the same, the probable cost of these would be in the neighborhood of one-sixth of the estimate for machinery and its installation. It should be noted that commonly deck auxiliaries are classed with hull outfit.

An Apprenticeship Course for Shipfitters

(Concluded from page 156.)

ONE MONTH.—Preparation of an estimate for work planned and routed in minute detail for shipfitting and related trades. Checking up material list showing exact shop sizes, amounts to be used and amounts of waste from commercial or standard sizes.

THREE-YEAR COURSE IN APPLIED SCIENCE (THEORETICAL KNOWLEDGE OF THE TRADE) FOR SHIPFITTERS

First Year

ONE MONTH.—Types and manufacturers' names of materials, tools and appliances. Use of the common tools, such as hammers and cold chisels.

FOUR MONTHS.—Study of the processes of drilling and reaming. Handling of different kinds of drills and reamers, rivets, and bolts; different kinds of cold chisels. Study of how these tools are made: meaning of hardening, tempering and annealing; effect of heat on metals. Principles underlying calking and very elementary principles of pneumatic tools.

FOUR MONTHS.—Study of the simple mechanical principles underlying the manipulation of hand tools, such as leverage (handles) of hammers, cutting edges (wedges), etc.

THREE MONTHS.—Descriptions and uses of measuring tools, such as metal gages, micrometers, calipers. Units of work. Specific gravity (weight of metal per square foot).

Second Year

ONE MONTH.—Study of the raw materials and processes used in their preparation—cast iron, wrought iron, steel, mild steel, high carbon steel. Special treatment of steel, vanadium and tungsten metals.

THREE MONTHS.—Study of the properties of water pressure, involving the properties of liquids applied to hydraulic machinery, such as hydraulic keel benders, etc. Buoyancy of water; explanation of "why a boat floats"; watertightness.

ONE MONTH.—Study of air pressure involving the properties of gases. Mechanism of pneumatic tools, airtight condition of compartments.

THREE MONTHS.—Explanations of the mechanism of various power tools used in building the specific hull upon which the apprentice is engaged, such as butt riveter, drill presses, punching machines and cold press.

ONE MONTH.—A short description and study of the design of a shipshape, parts and materials used.

THREE MONTHS.—The scientific principles underlying the design of a ship. The theory of displacement and buoyancy (elementary).

Third Year

SIX MONTHS.—The principles of hygiene and safety explained to apprentices. The care of the body; the kind of clothing worn; the dangers of the trade and how they may be prevented, such as falling from scaffolds. The theory of displacements and drafts under loads, center of gravity, buoyancy, inclination under weights.

FIVE MONTHS.—The principles of the strength of materials applied to iron and steel in a ship. Use of such terms as tensile, shearing and compressive strength.

ONE MONTH.—Composition of metals and alloys.

Shipbuilding and General Marine News

Contracts for New Ships—Shipyard Improvements—
Engineering Projects—Improved Appliances—Personal Items

MILLION-DOLLAR CONTRACT FOR WARRIOR BARGES AWARDED

Bids Open for Cargo Barges for New York State Canal

On February 2, the Railroad Administration, announced the closing of the contract for four self-propelling barges of 2,200 tons, each costing \$244,000, with the St. Louis Boat Engineering Company, St. Louis, Mo. At the same time twenty wooden barges of 500 tons, costing \$6,000 each, were ordered from the Murnan Shipbuilding Company, Mobile. In anticipation the Murnan Shipbuilding Corporation entered into negotiations for material to build the vessels in the latter part of January. Officials of the company say it will require three months for the completion of all the barges.

There still remains the announcement of contract for three steel boats to be used in the same fleet. No official statement has been made regarding the contractor selected, but the Howard Shipbuilding Company, of Jeffersonville, Ind., is the lowest bidder, and will probably secure the order.

Details of British Shipbuilding Production

The production of ships in various parts of the United Kingdom during 1918 is shown in the following table:

	Vessels	Tons	I.H.P.
Scotland	592	633,748	1,969,670
England	599	1,029,017	2,192,056
Ireland	53	213,646	287,580

The output of the leading districts was as follows:

	Vessels	Tons	I.H.P.
The Clyde	440	555,803	1,900,595
The Tyne	111	361,165	935,956
The Wear	62	269,628	288,030
The Tees	80	227,840	297,675
Ireland	53	213,646	287,580

The production from the largest yards is as follows:

	Vessels	Tons
Harland & Wolff (three yards)	35	219,567
Harland & Wolff (Belfast only)	15	119,445
Swan, Hunter & Wigham Richardson	29	82,214
Workman, Clark & Co.	19	69,370
William Gray & Co.	16	62,058
Russell & Co.	10	59,685
William Doxford & Sons.	11	44,967

German Shipbuilding During the War

Rather specific details are given out by the War Trade Intelligence Department of Great Britain regarding ship construction in Germany during the war. As reported by an employee of the Vulcan Werft, Hamburg, during the period from 1914 to 1917 this company was engaged chiefly in constructing torpedo boats and battleships.

Since the launching of the hull of the new 52,000-ton merchant ship, the *Bismarck*, in June, 1914, spare labor has been utilized in fitting out the vessel. Besides the Vulcan Werft another large shipyard has been made ready for the Hamburg-Amerika Line, where merchant ships of 10,000 tons will be built for the post-war trade. The informant reports also that at the Reihestiegwerft, Hamburg, several standard ships of 4,000, 8,000 and 12,000 tons were constructed.

CONTRACTS LET FOR MISSISSIPPI BARGE FLEET

Fifty-nine Barges and Ten Towboats Will Be Used for This Service

On page 161 of this issue of MARINE ENGINEERING a complete description of the equipment for the upper and lower Mississippi barge fleet appears.

Contracts for these vessels have been let as follows:

To the Dravo Contracting Company, Pittsburgh, Pa., six 300-foot steel hopper barges; six boats of the same type to the Dubuque Boat & Boiler Works, Dubuque, Ia., and seven to the Marietta Manufacturing Company, Point Pleasant, W. Va.

Up to the present all bids have been rejected for building the four upper river towboats, which are to be 256 feet long, of steel. It is reported that these will probably be built at the Government shipyards in St. Louis.

Contracts for the forty barges used on the lower route have been let as follows:

Twenty-five to the American Bridge Company, Ambridge, Pa., and fifteen to the Dravo Contracting Company, Pittsburgh, Pa. These barges are of steel, and will be 230 feet long.

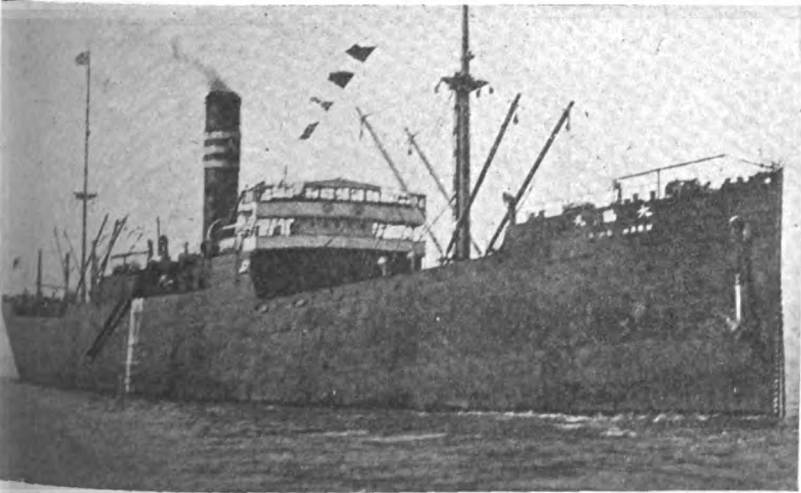
The steel towboats for the lower Mississippi route are to be built by the Charles Ward Engineering Company, Charleston, W. Va., and the Marietta Manufacturing Company, Point Pleasant, W. Va. Two of these will be constructed by the former company and four by the latter. The boats will be two hundred feet long.

CANADIAN SHIPYARDS TO BE GREATLY ENLARGED

Clyde Builders Will Shift Operations to British Columbia Coast

Yarrow & Company have officially announced that they intend gradually to diminish their output on the Clyde and develop their works on the Pacific Coast of North America. Harold E. Yarrow, managing director of the works on the Clyde, is visiting America to study conditions here.

When interviewed, officials of the company gave several definite reasons for their decision. They reported that they found it quite as advantageous to purchase steel from American mills, that transportation facilities were more advantageous, and that the labor problem was less difficult on the Pacific Coast.



The Steamer *Taiho Maru*, Built at Osaka, Japan, Which Touched the Port of Seattle in Ballast Just Six Months After the Steel for Her Hull had Been Shipped from That Port

**BIG SHIP REPAIR PLANTS
TO BE BUILT****Millions to Be Expended in Erection of Drydocks and Repair Shops at New York and Philadelphia**

Plans for the erection of immense ship repair plants in both New York and Philadelphia are being made, it is rumored, by a large corporation, headed by some of the most experienced shipbuilders in the United States and backed by millions of dollars in capital.

According to reports, the plans provide for the construction of a number of large floating drydocks, together with shops and repair facilities, on the Hudson River near New York, and also on the Delaware River near Philadelphia.

The new plants will be equipped for the repair of the largest vessels afloat.

**GOVERNMENT'S HUGE
UNDERTAKING****Norfolk Navy Yard Will Cost
Over \$11,000,000**

Censorship upon the building operations at the Norfolk navy yard has been lifted so that a more accurate idea of the operations being undertaken is available.

The following list of important items gives a fair idea of the work under way:

Structural steel building for the laying out of battleships, \$1,400,000; new slips for the accommodation of vessels under repair, \$1,200,000; new drydock No. 4, \$400,000; naval hospital, \$1,200,000; foundry building, \$600,000; pattern shop, \$400,000; power house, \$700,000; lumber storage warehouse, \$350,000; crane runway, \$460,000; coal handling plant, \$100,000; naval magazine, \$410,000; central power plant, \$350,000; mine-building plant, \$350,000; six mine storage buildings, \$50,000 each, and two storehouses, \$250,000.

**H. C. Higgins Succeeds Rear
Admiral Bowles as Assistant
General Manager of the
Emergency Fleet
Corporation**

Howard C. Higgins, formerly representative of the United States Shipping Board Emergency Fleet Corporation at the shipyard of the Submarine Boat Corporation, Newark, N. J., and more recently representative of the Emergency Fleet Corporation at the Hog Island yard of the American International Shipbuilding Corporation, has been appointed assistant general manager of the Emergency Fleet Corporation, succeeding Rear Admiral Francis T. Bowles, resigned.

Mr. Higgins is a member of the Council of the Society of Naval Architects and Marine Engineers, and up to the time the United States entered the war had been for years superintending engineer of the Old Dominion Steamship Company, New York.

**Emergency Fleet Activities
Abroad**

It is reported that a representative of the Emergency Fleet Corporation is in France to arrange for the selling of one of the large shipbuilding plants on the Pacific Coast. The plant is only partially completed, work having been halted at the signing of the armistice. It is also understood that the representative will seek to arrange that certain equipment suitable for shipbuilding now in France be sold to advantage.

**\$3,435,000 CONTRACT FOR
COAST GUARD CUTTERS
GOES TO WESTERN
YARD****Everett, Wash., Shipyard to
Build Five Before April
1, 1920**

As announced in brief in the February issue, the Navy Department has signed one of its largest contracts with the Norway Pacific Construction & Dry Dock Company, Everett, Wash., for the construction of five coast guard cutters at a total cost of \$3,435,000. The bid of this company was about \$12,000 lower than any competitor. The contract calls for the delivery of the ships between December 1, 1919, and April 1, 1920. Olaf Hetlesater, naval architect of the company, is now planning the work, so that it can be rushed as soon as the first steel shipments are received. It is expected that the first keel can be laid about March 15.

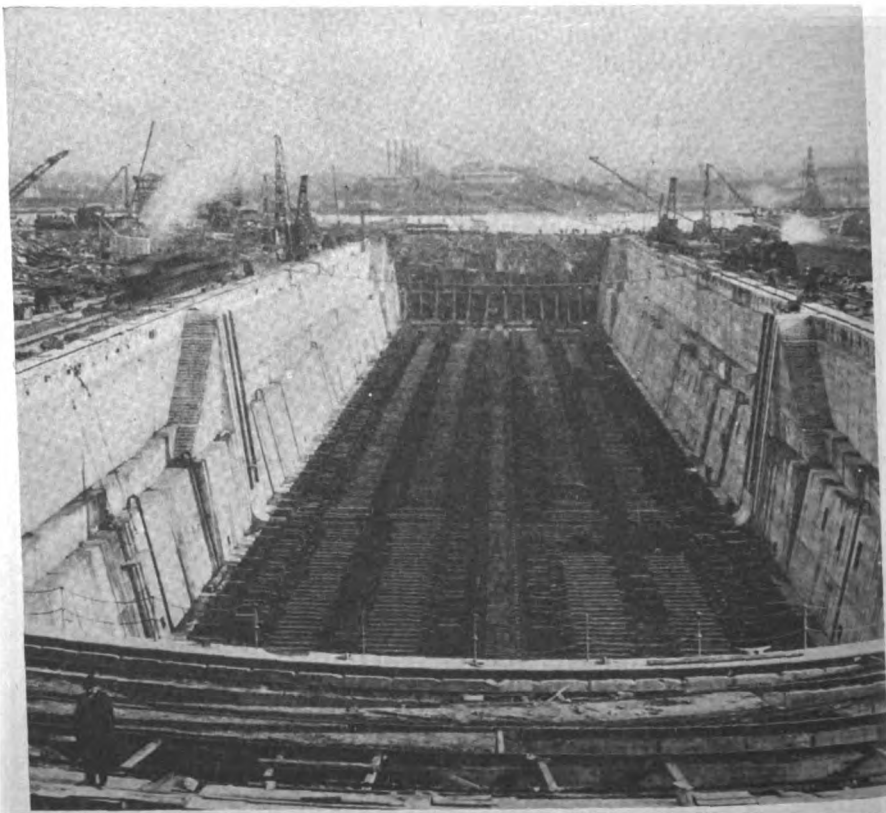
**FOUNDATION COMPANY BIDS
FOR FOREIGN CONTRACT****Large Contract Awaits Government Approval**

It is stated that contracts have been secured by the Foundation Company, 233 Broadway, New York, from the French Government totaling \$200,000,000. All negotiations await the approval of the United States Government. The contract calls for 174 steel cargo vessels. The report is not denied by the Foundation Company.

The Foundation Company is still endeavoring to have the yards at Tacoma and Portland opened for private contracts. So far the Government has declined to allow the company to build for foreign account, although Government contracts are withheld. For this reason the company was compelled to establish its shipbuilding yard at Victoria, B. C., where twenty 3,000-ton twin-screw wooden steamers are being built for the French Government. The company gives out the information that four foreign governments are negotiating for the establishment of shipyards under Foundation Company control in their respective countries.

New Ships for the Cunard Line

Sir Ashley Sparks, on his arrival at New York, announced that the Cunard Line had mapped out a ten-year building programme, and would construct ships of the type of the *Tuscania* and *Francia*, of 14,000 and 18,000 gross tons, respectively.



The Norfolk Drydock, Largest in the World, Opened on February 1

SHIPYARD IMPROVEMENTS

New England States

The Machias Ship Construction Company, Machias, Me., is making over the steel coal barge *Coastwise* into a sailing vessel. This vessel is the third of a fleet of colliers sailing along the New England coast which are being made over into full rigged ships.

Contract has been let for a new machine shop for the Navy Department, Portsmouth, N. H., aggregating \$122,906.

The Fore River Shipbuilding Corporation, Quincy, Mass., including the branch plant at Squantum, is now giving employment to over 25,000 men. The plant is said to have orders on hand to allow for full operations throughout the coming year.

The Boston Dry Dock & Shipbuilding Company, Jeffries Point, East Boston, is preparing to build a ship repairing plant costing \$6,000,000.

The Marine Engineering & Dry Dock Company, Providence, R. I., is planning to build a ship repair plant and several drydocks.

The Crowninshield Shipbuilding Company, Providence, R. I., is said to be considering the building of a new marine railway of 3,500 tons capacity at the South Somerset yard.

The Narragansett Shipbuilding Company, Tiverton, R. I., is building a 20,000-ton drydock to cost around \$1,000,000, including equipment. The contract has been placed by the Shipping Board; the new drydock will be operated at New York.

Middle Atlantic States

The Marine Construction Company of New York has launched a sectional dock, 120 by 85 feet, with 16-foot depth, at Bartow, Fla. Three additional docks will be built. It is planned to tow these to New York.

The Westinghouse Electric Company is planning to quadruple the present capacity of the Essington plant. The company still holds contracts for equipping 150 of the Emergency Fleet Corporation's ships with Westinghouse propelling machinery.

The Hudson Shipbuilding Corporation are contemplating making a one-story addition to their plant which will cost about \$20,000.

Three new ways have been built at the Bethlehem Shipbuilding Corporation at Sparrow's Point, and the Union Shipbuilding Corporation at Fairfield are planning to build six ways in addition to the four now under construction.

Plans for a two-story brick and concrete office building, to be erected at the Sparrow's Point plant of the Bethlehem Shipbuilding Corporation, are perfected by the company's architect, Edward L. Palmer, Jr.

The Bethlehem Shipbuilding Corporation is also planning the erection of a

pumping plant to cost \$25,000 at its Sparrow's Point, Md., yard.

The shipyard being built under the direction of the Emergency Fleet Corporation, Washington, D. C., at the upper end of Gloucester City, N. J., will be ready for operation early in March, by the New York Shipbuilding Corporation, Camden, N. J., as an extension to its present works. The plant will cost about \$10,000,000, covering a site of about 50 acres on the Delaware River. About 4,000 men will be employed at the yards. Among the structures now nearing completion are a plate and angle shop, about 200 by 780 feet, four general works buildings, each about 100 by 500 feet, and a brick and steel storehouse. Considerable machinery and equipment are being installed in different sections of the plant. The shipyard has been constructed by the Hugh Nawn Construction Company, Boston, Mass.

The Traylor shipyard at Cornwells, Pa., operated by the Traylor Engineering & Manufacturing Company, Allentown, is planning to establish a permanent shipbuilding plant after the Government orders, now building, are completed.

The Chester Shipbuilding Corporation, Chester, Pa., is planning to build a two-story shop to cost about \$25,000.

The ship chandlery business of the Bie & Schiott Company, Inc., Philadelphia, Pa., has been taken over by the Norden Ship Supply Company, recently organized. H. Gulbranson, I. Westergaard and P. L. Bjornsgaard are connected with the new company.

The Navy Department is planning to build an addition to the machine shop at Indian Head, Md.

The Bureau of Yards and Docks, Washington, will build an electric substation for operation at Piers A and B, League Island, Philadelphia, Pa. It is understood that extensions will be made in a number of shop buildings at the yard to increase the present facilities.

The Pusey & Jones Company, Gloucester City, N. J., has recently consolidated operations at its New Jersey shipyard, following the issuance of orders about the middle of February, covering the suspension on plant construction, then under way, and on ships known as C-13 to C-19, and H-204 to H-212. The plate and angle shop and the mold loft at the New Jersey yard have been closed down temporarily. It is reported that the Emergency Fleet Corporation will probably turn over the plant to the private company. Under these conditions the plant will be immediately started up for the construction of a number of vessels for private interests, contracts for which, it is understood, have recently been received. The bulk of production up to the present time has been devoted to oil tankers of 7,000 tons capacity.

The Federal Shipbuilding Corporation, Kearny, N. J., a subsidiary of the United States Steel Corporation, has its twelve shipways occupied at the present

time by vessels under construction for the Emergency Fleet Corporation. With previous deliveries, the company's contract with the Government calls for the construction of ten steel vessels in addition to the twelve now being built. It is planned to complete three of these vessels early in April and, closely following, to inaugurate construction work on steel freighters and ships of other types for private interests. The first three vessels to be built at the yard will be designated for use by the parent corporation. The plant is now giving employment to close to 9,000 men.

The Submarine Boat Corporation, Port Newark, Newark, N. J., is now giving employment to about 12,500 men, and it is proposed to increase this number to a total of over 15,000 at an early date. The company has a contract covering the building of 150 steel vessels for the Emergency Fleet Corporation, each of 5,500 tons capacity, an order for fifty being signed in September, 1917, and supplementary contracts bringing the total up to the amount noted. It is planned to bring production at the plant up to a maximum capacity of twelve launchings a month during the coming summer.

A one-story addition, costing about \$10,000, is being begun by the Sun Shipbuilding Company, Chester, Pa.

Southern States

The Mobile Shipbuilding Company, Mobile, Ala., has increased its capital stock from \$1,000,000 to \$5,000,000.

The Colonial Marine Railway Corporation, of Norfolk, Va., has increased its capital to \$500,000. Another Virginia company located at Weems, Humphreys Marine Railways & Lumber Corporation, has increased its capital stock from \$25,000 to \$75,000. The company will build a 1,000-ton marine railway and install machinery, including crude-oil engine, with generator to operate two marine railways of 500 to 1,000 tons capacity and other machinery.

The Marietta Manufacturing Company, Point Pleasant, W. Va., will build an addition to its marine ways in order to provide facilities for constructing the river barges to be built for the Government.

The Fred T. Ley Company, Mobile, Ala., main office, Berkeley Arcade, New York, has begun the construction of concrete vessels. Two boats are now being erected at the present time, with plans for launching in March. It is understood that a number of such boats will be constructed at the works, maintaining operations at normal.

The International Shipbuilding Company, Pascagoula, Miss., the capacity of whose yards now permits them to build ten steel vessels at once, are planning to enlarge their plant as soon as possible. They are also arranging to construct a railroad which will connect the shipbuilding plant with a new waterfront terminal to be constructed in the near future.

The McBride & Law Company, of Beaumont, will build a drydock at Port Arthur.

The Foundation Company, 233 Broadway, New York, has recently completed the erection of a new electric power plant for works operation at its yards at Savannah, Ga.

The Norfolk Shipbuilding & Dry Dock Company, Norfolk, Va., has broken ground for the construction of two additions to its plant on Argyle avenue, for increased facilities.

A one-story machinery warehouse has been contracted for by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va.

The Navy Department will shortly issue a list of cranes to be installed in the armor plate plant now under construction at Charleston, W. Va.

Western States

Upon a 40-acre site provided by Kewaunee, Wis., work will soon be begun by the Wisconsin Shipbuilding & Navigation Corporation upon a new shipbuilding plant. Facilities will be provided for building six 3,500-ton vessels per year suitable for Great Lakes and ocean service.

Bids will be opened after February 21 to build a floating drydock to cost about \$400,000 at Green Bay, Wis. F. Early, of Chicago, is the engineer who has prepared the plans.

The Dubuque Boat & Boiler Works, Dubuque, Ia., is building two coast guard cutters for the United States Navy, Nos. 32 and 34. These boats, which are of 34-foot beam, 179 feet long and 3-foot draft, are stern-wheel vessels.

Side by side with the development of larger vessels, reports from Seattle show that many small fishing boats will be constructed in Tacoma before the spring. Inquiries have even been received from Eastern companies, which show how tied up Eastern yards are for this type of building.

A new track will be built at the Pacific Coast Shipbuilding Company's yard on the upper Suisun Bay. Space is also being cleared for an addition to the warehouses of 100 by 100 feet. It has been necessary to enlarge the housing and sleeping facilities to accommodate the men now employed. The 110-room hotel will cost about \$150,000.

The Astoria Marine Iron Works, Astoria, Ore., it is reported, will be developed into a steel plant for the fabrication of marine and structural iron. Plans for a marine railway of 6,600 tons have already been approved. The present buildings and facilities are also to be enlarged.

Reports show that repairs on marine work are increasing in the Tacoma plant of the Coast Iron & Machine Works, which is engaged in all types of machinery installation work for that district.

Several shipyards in the California district are reported as buying machine

shop equipment for installation at the yards.

Canada

The National Shipbuilding Company, Goderich, Ont., are in the market for new machine shop equipment.

The Prince Rupert Shipbuilding & Engineering Company, Prince Rupert, B. C., has been organized to build steel ships, with a capitalization of \$500,000. J. L. Mullen, of the Mullen Construction Company, Pittsburgh, Pa., is president.

Plans for a new shipyard at Vancouver, B. C., are being made by the Foundation Company through the manager of the proposed works, Bayley Hipkins.

A new boiler house and other extensions are planned by the Dominion Shipbuilding Company of Toronto, Canada.

With the capitalization of \$100,000, the Watson Dry Dock & Construction Company plans to build a floating drydock and shipbuilding plant at Victoria, B. C. Small vessels of 300 tons, tugs and scows will be repaired and equipped.

A boatbuilding firm at Shelburne, Nova Scotia, is now filling an order for seventy lifeboats, to be 20 to 24 feet long, and many dories. A recent shipment included 100 dories sent to St. Pierre.

Plans are in progress for an addition to the shipbuilding plant of the Western Canada Shipyards, Ltd., Carroll street, Vancouver, B. C., to cost \$43,500.

Foreign

The Kawasaki Dock Company, of Kawasaki, Japan, has increased its capital stock to \$24,000,000. The greater part of the new stock is being given to faithful workmen of the concern. The president of the company, K. Matsukata, has announced the establishment of the Daifuki Steamship Company in Japan, with a capital of \$9,960,000.

The Harland & Wolff Company, Belfast, it is reported, has purchased the steel works of David Colville & Sons, Ltd., of Motherwell and Glengarnock, Scotland, with a view to having first call on their steel production.

To make the Swedish industry independent of foreign supplies a new company has been formed at Gothenburg, with a capital of \$7,500,000, for the manufacture of ship and marine engine specialties.

The Schichau Shipbuilding Works, one of the most important in Germany, has been sold to an American concern for 160,000,000 marks (\$40,000,000), according to recent newspaper reports.

Floating Drydock for Hoboken

W. & A. Fletcher Company, Hoboken, N. J., will construct a huge floating drydock, to cost about \$1,500,000. In addition, a large plate shop will be started on the block between Fourteenth and Hudson streets.

HARBOR IMPROVEMENTS

Atlantic Coast

The Dominion Government of Ottawa has voted \$50,000 for waterfront improvements.

A petition to appropriate \$500,000 for improving East Boston ferry slips has been entered before the State Legislature. Petition is also being forwarded to authorize the dredging of the Mystic River from the creek to the sea, and for the building of docking facilities.

The New York State Legislature has received a petition for the appropriation of \$950,000 to build extensive canal terminals at Kingston, Newburgh, Poughkeepsie and Yonkers. Separate petitions have been issued by Waterloo and Seneca Falls, N. Y., of \$100,000 each for terminal barge facilities at these ports.

It is planned to widen the harbor of Norfolk from Hampton Roads to Elizabeth River Belt Line.

On February 3, the New London City Council, New London, Conn., approved a petition to the State Legislature for authority to issue \$1,000,000 in bonds for waterfront improvements.

Arrangements are being made for the bonding of the city of Pascagoula, Miss., for \$100,000, to be utilized for port improvements along the 800-foot waterfront owned by the city.

The Navy Department plans to build a timber wharf at Norfolk, Va., to cost \$55,000.

A movement is on foot to jetty Cape Fear bar to obviate the continuous dredging, which is necessary at present.

The Texas Oil Company has applied to the City Commissioners of Pensacola, Fla., to build a wharf, which will be 1,830 feet long, 30 feet wide, and with a frontage of 480 feet and an extension to the eastward of 600 feet.

The cities of Galveston, Texas City, Houston, Port Aransas, Beaumont, Orange and Port Arthur have formed a commercial association to further questions of trade and harbor improvement.

The City Commission of Jacksonville, Fla., has been authorized to secure a first-class fireboat, to be purchased at an expense of not over \$150,000. A naval architect will be selected for the drawing up of the plans at once.

The Navy Department has issued plans for waterfront improvements at Key West costing \$1,676,000.

Tampa, Fla., is arranging to construct a slip and an improved pier which will cost about \$180,000.

Authorization by the Federal Government for the construction of a 5,000-ton drydock at Pensacola has been reported.

Work on the North Charleston terminal facilities will be completed about April 1. The cost will reach about \$17,000,000. The improvements will include six covered warehouses 1,200 feet long. The docks accommodate the largest ocean vessels.

Within the past three years Portland, Ore., has voted \$8,000,000 for port improvements. The last bond issued was authorized on November 6, 1918, for \$5,000,000. The previous \$3,000,000 issued is being used in the construction of a grain elevator and for port improvement in the vicinity.

Pacific Coast

Pier No. 1 at Portland was opened for business on February 8. The covered section of the pier extends 600 feet inshore from the harbor line. It is two stories in height.

Astoria, Ore., plans to sell \$750,000 in bonds for port improvements, including a one-mile belt extension, large warehouse, dredging of the Skipanon River, and providing side tracks at port terminals.

The Board of State Harbor Commissioners of California is about to let contracts, amounting to about \$2,000,000, to improve the port of San Francisco. Among the projects are: Building six double-decked bulkhead warehouses, intended primarily for foreign trade; extension of the present seawall along the front between the piers; extension of several piers to full length allowed by Government; a 500-foot pier to replace old Pier No. 1, to be built by H. B. Hanna Company, and the installation of modern cargo-handling equipment on the harbor docks.

Contract has been signed by the Seattle Commission with the firm of Harrington & Peters for the construction of the sub-structure of the new Smith-Cove terminal, known as Pier B, which calls for an expenditure of \$567,600. The commission has also drafted a petition to the United States engineer asking for permission to extend the Smith-Cove harbor line approximately 50 feet.

A contract has been let for the construction of a huge pier on Smith Cove, Seattle, which will cost about \$2,300,000.

The contemplated harbor development at Tacoma, Wash., will embrace the building of piers and slips on the Herring plan. A waterway 1,000 feet wide is to be maintained, with piers and slips at an angle of 45 degrees and 800 to 900 feet long.

Preliminary plans for dock and warehouse improvements to be constructed at Tacoma, Wash., were brought before the Pierce County Port Commission on January 29. Frank A. Walsh is the chief engineer.

J. B. Hegardt, of Portland, Ore., is arranging to build a \$900,000 dock for the city of Portland on the St. John's municipal terminal. The construction will be of wood of 12,000-ton capacity. It is understood that bids are now open.

Baltimore will have a new \$100,000 pier as planned by the Standard Oil Company to replace the pier now handling the work. Thomas Goodwillie, Pier 2, Pratt street, wharf, is engineer in charge.

Funds are now available for the dredging of the Willapa River, Raymond, Wash.

Oregon Will Use \$5,500,000 for Building Port Improvements

Five and one-half millions of dollars are available for use in connection with the expansion of port facilities in Portland, Oregon. Among other improvements it is planned to construct a 12,000-ton drydock and an additional pier, 1,500 feet long.

Mechanics' Liens Placed on Atlantic Corporation Steamers

Creditors of the Atlantic Corporation, Portsmouth, N. H., are co-operating with the shipbuilders in a suit to compel the Emergency Fleet Corporation to pay a "fair price" for the construction of ten steel steamers, which the corpora-

tion has contracted to build, or to cancel the contract. Mechanics' liens have already been placed upon the hulls of six steamers now in the course of construction. The total amount of outstanding indebtedness, according to the officials of the Atlantic Corporation, is \$609,000.

Marine Boiler Shop at Richmond

Work upon the marine boiler plant which will be built at Richmond, Va., for the Newport News Shipbuilding & Dry Dock Company is to be resumed. Temporary suspension of building plans followed the signing of the armistice. Orders for cranes and plate-working machinery, which were included in the original specifications, will doubtless be reinstated.

LAUNCHINGS OF THE MONTH

Date of Launch	Name of Vessel	Deadweight Tonnage	Type	Builder	Owner
Jan. 29	Fort George.....	3500	Ferris Wood	J. M. Murdock, Jacksonville	Emergency Fleet Corporation
Jan. 29	Unnamed.....		Concrete Barge	Liberty Shipbuilding & Transportation Co., Cleveland	Emergency Fleet Corporation
Jan. 30	Farnan.....	5000	Steel Cargo	Submarine Boat Corporation, Newark	Emergency Fleet Corporation
Feb. 1	Oscoda.....	8800	Steel Cargo	Baltimore Dry Dock & Shipbuilding Co., Baltimore	Emergency Fleet Corporation
Feb. 8	Laurel.....	6200	Steel Cargo	Baltimore Dry Dock & Shipbuilding Co., Baltimore	Emergency Fleet Corporation
Feb. 1	Walden.....	9000	Steel Cargo	Newburgh Shipyards, Inc., Newburgh	Emergency Fleet Corporation
Feb. 3	Thomas W. Lipton	2000	Schooner	Brunswick Marine Construction Co., Brunswick, Ga.	Apex Navigation Corporation
Jan. 30	Ganeri.....	3500	Ferris Wood	Housatonic Shipyards, Stratford,	Emergency Fleet Corporation
Jan. 30	Tuckanuck.....	9400	Steel Cargo	Moore Shipbuilding Co., Oakland, Cal.	Emergency Fleet Corporation
Jan. 30	Bon Secour.....			Pacific American Fisheries Co., Bel- lingham, Wash.	Emergency Fleet Corporation
Jan. 29	West Selene.....	8800	Steel Cargo	Los Angeles Shipbuilding & Dry Dock Co., San Pedro,	Emergency Fleet Corporation
Feb. 1	West Capance....	8800	Steel Cargo	Los Angeles Shipbuilding & Dry Dock Co., San Pedro,	Emergency Fleet Corporation
Feb. 27	West Sequona....	8800	Steel Cargo	Los Angeles Shipbuilding & Dry Dock Co.,	Emergency Fleet Corporation
Jan. 30	Serritor.....	3500	Ferris Wood	Benicia Shipbuilding Co., Benicia, Cal.	Emergency Fleet Corporation
	Horado.....	3500	Ferris Wood	National Shipbuilding Co., Orange, Texas,	Emergency Fleet Corporation
Jan. 29	Hegiria.....	1300	Steel Cargo	Bethlehem Steel Corporation, Alameda, Cal.	Emergency Fleet Corporation
	Bob-o-link.....		Mine Sweeper	Baltimore Dry Dock & Shipbuilding Co., Baltimore, Md.	Navy
Feb. 2	Duquesne.....	9600	Steel Cargo	Federal Shipbuilding Co., Kearny,	Emergency Fleet Corporation
Feb. 5	Cormorant.....		Mine Sweeper	Todd Shipbuilding Co., Brooklyn, N. Y.	U. S. Navy
Feb. 8	Fore Pierce.....	3500	Ferris Wood	St. John's River Shipyard Co., Mobile	Emergency Fleet Corporation
Jan. 28	West Togus.....	8800	Steel	Northwest Steel Co., Portland,	Emergency Fleet Corporation
Feb. 12	Oration.....	3500	Ferris Wood	Traylor Shipbuilding Co., Cornwalls	Emergency Fleet Corporation
Jan. 25	Farquhar.....		Destroyer	Bethlehem Shipbuilding Corporation, Sparrows Point	U. S. Navy
Feb. 6	Fleurus.....		Mine Sweeper	Foundation Company, Savannah,	French Government
Feb. 8	Octoraro.....	1200	Schooner	Coastwise Shipbuilding Co., Locust Point,	Philadelphia & Read Transp. Co.
	Altura.....	3500	Ferris Wood	Ship Construction & Trading Co., Stonington, Conn.,	Emergency Fleet Corporation
Feb. 1	West Catanace...	8800	Steel Cargo	Southwestern Shipbuilding Co., East San Pedro,	Emergency Fleet Corporation
Feb. 27	West Sequana....	8800	Steel Cargo	Southwestern Shipbuilding Co., East San Pedro,	Emergency Fleet Corporation
Feb. 22	Yomachichi.....	9500	Steamer	Oscar Dnaisls Co., Tampa, Fla.,	Emergency Fleet Corporation
Feb. 4	Randfontein.....	1200	Steel	Marine Const. Co., St. John, N. B.,	
Feb. 8	Nesco.....	5500	Steel Cargo	Submarine Boat Corp., Newark, N. J.,	Emergency Fleet Corporation
Feb. 8	Jekyl.....	5500	Steel Cargo	Submarine Boat Corp., Newark, N. J.,	Emergency Fleet Corporation
Feb. 10	Magenta.....		Mine Sweeper	Foundation Co., Savannah	French Gov't.
Feb. 12	Lotgrier.....		Mine Sweeper	Foundation Co., Savannah	French Gov't.
Feb. 15			Mine Sweeper	Foundation Co., Savannah,	French Gov't.
Feb. 8	Steamer No. 753	3500	Ferris Wood	American Shipbuilding Co., Lorain, O.,	Emergency Fleet Corporation
Feb. 6	Woodbury.....		Torpedo Boat Dest.	Bethlehem Shipbuilding Corp., Sparrows Point, Md.,	U. S. Navy
Feb. 4	Alcis.....		Wood	Grant, Smith-Porter Ship Co., St. Johns	Emergency Fleet Corporation
Feb. 8	Unnamed.....	3500	Ferris Wood	American Shipbuilding Co., Lorain, O.	Emergency Fleet Corporation
Feb. 15	Passaic Bridge...	5500	Steel Cargo	Submarine Boat Corp., Newark, N. J.,	Emergency Fleet Corporation
Feb. 15	National Bridge..	5500	Steel Cargo	Submarine Boat Corp., Newark, N. J.,	Emergency Fleet Corporation
Feb. 15	Masca.....	5500	Steel Cargo	Submarine Boat Corp., Newark, N. J.,	Emergency Fleet Corporation

WAGE SCALE READJUSTED ON ATLANTIC AND GULF COAST

Opportunities for Soldiers and Others in the New Ma- rine Service

Award was made on December 30 covering a new scale of wages to go into effect on vessels of the Atlantic and Gulf Coast for licensed officers in deck and engine rooms. Some honest conflict of opinion had arisen after the signing of the armistice as to the application of the wage scale then in force, which led to the settlement of the terms as given below. This award becomes mandatory upon all vessels owned or requisitioned by the United States Shipping Board. The Board has also urged that private owners, and operators of vessels not requisitioned pay these wages voluntarily, in order that conditions in the industry may continue stable. The rates, which became effective on January 1, will remain in full force until May 1, 1919. Since the Shipping Board has not issued wage scales on the Great Lakes or the Pacific Coast, wages in these fields are settled by private arrangement.

The classes of vessels upon which wages shall be based are as follows:

CLASSIFICATION BASED ON POWER TONS (FIGURES ARE INCLUSIVE)		
Classes	Single Screws	Twin Screws
A.....	Over 20,001	Over 15,001
B.....	12,001 to 20,000	9,001 to 15,000
C.....	7,501 to 12,000	5,501 to 9,000
D.....	5,001 to 7,500	3,501 to 5,500
E.....	Below 5,001	Below 3,501

The wages for licensed officers are as follows:

	A	B	C	D	E
Masters	\$375.00	\$337.50	\$325.00	\$312.50	\$300.00
Chief engineer	287.50	268.75	250.00	231.25	212.50
1st officers and 1st assistant engineers.....	206.25	200.00	193.75	187.50	181.25
2d officers and 2d assistant engineers.....	187.50	181.25	175.00	168.75	162.50
3d officers and 3d assistant engineers.....	168.75	162.50	156.25	150.00	143.75
4th officers and 4th assistant engineers.....	150.00	143.75			
Junior engineers	125.00				

The above rates are flat, and do not contemplate the payment of bonuses in any form whatsoever.

From the above information, the possibilities for lucrative employment for those who wish to "follow the sea" are evident. Many men released from the service, who have acquired the "wanderlust," are enlisting in the merchant marine. Offices of the Shipping Board in all large seaports seem to be swamped with applications. The men in training, while rated as apprentices, receive \$30 per month with food, quarters and uniform. Under the May, 1918, ruling the pay for those branches of the service noted below serves to emphasize the good openings available:

DECK DEPARTMENT		Pay
Rating in Service		Per Month
Carpenter		\$90.00
Carpenter's mate		85.00
Boatswain		85.00
Boatswain's mate		80.00
Quartermaster		77.50
Able seaman		75.00
Ordinary seaman		55.00
Deck boy		40.00

STEWARD'S DEPARTMENT		Pay
		Per Month
Chief steward	\$100.00 to	\$145.00
Chief cook	100.00 to	120.00
Baker	95.00 to	105.00
Second cook		90.00
Second steward		85.00
Butcher		85.00
Second baker		75.00
Storekeeper		75.00
Pantryman		65.00

Vegetable cook	65.00
Third cook	60.00
Messman	60.00
Scullion	60.00
Messboy	55.00

ENGINE ROOM

Oiler	\$80.00
Water-tender	80.00
Engine room storekeeper	80.00
Fireman	75.00
Coal-passer	65.00
Wiper (on oil burners)	65.00

The applicant must be: (1) An American citizen; (2) between the ages of 18 and 35, inclusive; (3) physically sound; (4) at least 5 feet 4 inches in height; (5) not less than 125 pounds in weight for deck service, or 140 pounds for engine room work. Men trained by the Shipping Board must agree to serve for one year from the date of their acceptance for training. In arranging the trips, in so far as it is possible, the men are shipped to different ports on each voyage so that they may have an opportunity to see the world.

A new schedule of wages has been adopted by the Marine Engineers' Beneficial Association, to apply on boats operating on the Great Lakes. The schedule calls for an advance of wages on passenger boats and lumber-carrying steamers. On bulk freight steamers on which engineers are employed by the season little change will be made. De-

Ten Large Vessels Sought

Inquiry has been received by MARINE ENGINEERING for vessels as follows:

Four of 10,000 tons deadweight, for passenger and freight service like the Lamport & Holt ship *L'auban*, to make fifteen knots; three cargo ships, of 4,000 tons deadweight, to make about twelve knots; two passenger and freight vessels, of about 1,000 tons deadweight each, of sixteen or seventeen knots. Those offering bids should be in a position to deliver the vessels in from twelve to eighteen months.

The contracting parties are also ready to purchase for cash at once one cargo steamer, 8,000 to 8,600 tons deadweight. Kindly forward bids at once, care of MARINE ENGINEERING, specifying details, cost, terms of payment, time of delivery and other necessary information.

Ship Contracts of the Month

Bids were closed on February 18 for the construction of twenty steel combination power and cargo barges for the New York State Barge Canal. The awards have not yet been announced.

The Todd Shipyards Corporation, 15 Whitehall street, New York, has received an order from the United States Navy Department to build six self-propelled steel oil barges.

Charles H. Tonney & Company, of Hampton, Vt., has obtained a contract for three 4,000-ton freight steamships.

The Toyo Kisen Kaisha announces that two new liners will be constructed for service on the Pacific of 33,428 tons displacement.

Yards Affected by Recent Cancellation of Ship Contracts

The complete list of plants receiving suspension orders, and the number of vessels upon which operations were suspended in the last ruling of the United States Shipping Board, is as follows:

Chester Shipbuilding Company, Ltd., Chester, Pa., 7; Terry Shipbuilding Corporation, Port Wentworth, Savannah, Ga., 5; Mobile Shipbuilding Company, Mobile, Ala., 12; American International Shipbuilding Corporation, Hog Island, Pa., 20; Merchant Shipbuilding Corporation, Harriman, Pa., 20; Ames Shipbuilding & Drydock Company, Seattle, Wash., 3; J. F. Duthie & Company, Seattle, Wash., 3; Todd Drydock & Construction Corporation, Tacoma, Wash., 12; Los Angeles Shipbuilding & Drydock Company, San Pedro, Cal., 10; Long Beach Shipbuilding Company, Long Beach, Cal., 6; Hanlon Drydock & Shipbuilding Company, Oakland, Cal., 6; Western Pipe & Steel Company of California, South Francisco, Cal., 4; Southwestern Shipbuilding Company, Long Beach, Cal., 8; Albina Engine & Machine Works, Inc., Portland, Ore., 4; Northwest Steel Company, Portland, Ore., 8; Columbia River Shipbuilding Corporation, Portland, Ore., 4.

tails of the schedule will be published as soon as conferences have been held with boat owners.

American Army Will Use Rotterdam and Antwerp

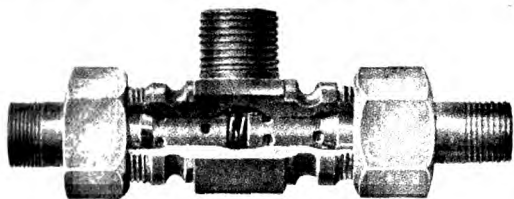
Rotterdam and Antwerp will be used as base ports for the American army of occupation. Warehouses will be erected here, and ships will be unloaded and reloaded upon deep draft brages which formerly belonged to the German Empire.

Yearly Report of Great Lakes Traffic

According to the annual report of the Lake Carriers' Association, although Government purchase for ocean service took eleven ore carriers from the lakes at the beginning of the season, and twelve more were removed through other sales and various causes during the year, the fleet moved 107,146,242 net tons of ore, coal and grain. While this is a decrease of 1,205,357 as compared with 1917, the report points out that the navigation season was of but little more than seven months' duration, and that at no time were water levels favorable to maximum movement.

Automatic Relief Valve for Steam Cylinders on Ship Auxiliary Machinery

The Dew automatic relief valve, manufactured by the Dew Valve Company, Inc., 149 Broadway, New York, for draining steam cylinders is especially useful on auxiliary ship machinery, such as winches, windlasses, pumps, etc., where the saving of fuel and fresh water is of prime importance. The valves completely drain all condensation in each cylinder at every stroke, as the valves are automatic in their action, and



Section of Dew Automatic Relief Valve

when steam is on the one end of the valve the other is open to drain. This operation is continuous as long as the winch is in operation. When the winch is idle the spring inside the two valves in the body casting forces both valves open, so that both ends of the cylinder are drained simultaneously. By connecting the exhaust from each valve to the main exhaust line for the winches all condensation is piped back to the condenser or receiving tank, thus saving fresh water.

The Dew valve is applicable for all auxiliary machinery for both marine and stationary plants.

The valve consists of a main brass casting, having two inlets for receiving

end are hollow, with small holes in each to take the condensation from the cylinder when the valve is opened by the compression spring inserted in them. The spring is placed in these valves to insure both being opened when no steam is on the cylinder. The seating of one valve insures the opening of the other when steam is on, as the valves are made of such length that the two cannot seat at the same time.

In each end of the main casting there is a brass ferrule, held in place by a brass hexagon nut, screwed to the body casting. These ferrules project beyond the nuts a sufficient distance to permit of attaching the drain pipes from each end of the cylinder.

It is obvious that in ship work, where time is a great factor, this valve would save many times its cost by insuring the safety of the winches alone from the possibility of burst cylinder heads and attending damage caused by water in the cylinders. There are no stems to be bent by cargo handling and no valves to be packed. By taking care of all condensation it is unnecessary to spend the usual time to warm up the winch before handling cargo.

These valves are in use on auxiliary machinery on ships of the Standard Oil Company, Pan-American Steamship Company, Southern Pacific Steamship Company and others.

Demand for Grey Iron Ship Castings Met by Central Foundry Company

Lack of standardization in ship fittings, and the frequent changes which were made in ship design in the early days of the development of the emergency fleet, created a demand for a great variety of ship castings which existing facilities were inadequate to produce. To meet this demand the Central Foundry Company, New York, a year and a half ago started to make ship castings. Since that time the company has kept pace with the many varied demands in casting design and construction, as is substantiated by the fact that Central Foundry castings have been installed on over 322 ships, nearly all of which were for the Emergency Fleet Corporation. The United States Navy also purchased 62 tons of 30- and 48-inch cleats from this company.

The products of the Central Foundry Company include air extractors, mushroom ventilators, bitts and bollards, chocks, cleats, davit steps, fair leaders, mooring ports and rings, caval chocks, chain pipe, hawse pipe, bilge and ballast flanged pipe, coal and deck scuttles, sheaves, housings and windlasses. Some of the shipyards supplied with these castings were the Federal Shipbuilding Company, Kearney, N. J.; Groton Iron Works, Groton, Conn.; National Ship

Building Company, Orange, Tex.; Submarine Boat Corporation, Newark, N. J.; Merrill-Stevens Company, Jacksonville, Fla., and the Bayles Shipyard, Port Jefferson, N. Y.

Dunn Stockless Anchor

The stockless anchor, first designed in 1889 by H. O. Dunn, now a rear-admiral in the United States Navy, has demonstrated through years of service on all types of vessels that it holds fast under the most severe conditions. The crown and flukes are an integral steel casting into which is inserted the shank. The casting may rotate 90 degrees with respect to the shank, the elongated crown acting as a stock and providing a horizontal position for the flukes. Each fluke presents a large holding surface, and both flukes bite when any strain comes on the cables, thus giving tremendous holding power.

The Dunn anchor is drawn into and against the hawse pipe, the crown and flukes stowing snugly against the side of the ship and being kept rigidly in place by the tension of the chain. Thus it is ready for instant service in fair weather or foul, and does away with the laborious and often difficult process of catting an anchor on deck. Should a ship not be provided with a hawse pipe, however, the Dunn anchor can be supplied with a balancing band, which makes it exceptionally easy to cat and stow the anchor.

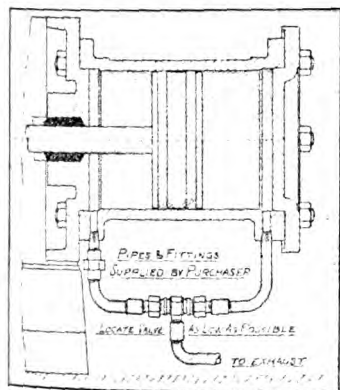
Dunn stockless anchors are approved by and pass all prescribed tests of the American Bureau of Shipping, Bureau Veritas, Lloyd's Register of British and Foreign Shipping, and the United States Navy. They are made at the Chester, Pa., plant of American Steel Foundries.

Material Handling Machinery Manufacturers' Association Establishes New York Office

Zenas W. Carter has resigned as commissioner of the Associated Metal Lath Manufacturers to become managing executive secretary of the Material Handling Machinery Manufacturers' Association, which has been formed by companies manufacturing material-handling machinery at the suggestion of the Department of Commerce and the United States Shipping Board. Offices will be established in New York City by March 1 at 35 West Thirty-ninth street.

Admiral Bowles Resigns from Emergency Fleet Corporation

Rear Admiral Francis T. Bowles, as assistant general manager of the Emergency Fleet Corporation, has tendered his resignation, to take effect on March 15. The announcement of Admiral Bowles' resignation was made by the Shipping Board on February 3, with the statement that Mr. Bowles probably would retain his connection with the Board in some other capacity.



Installation of Relief Valve

the drain pipes from each end of the cylinder, and one outlet for receiving the pipe for carrying the drainage to the exhaust pipe line or overboard.

Inside of the main casting there are two brass valves, each with a conical seat and of sufficient length so that both valves cannot seat at the same time. The heads of each of these valves are solid, to take the steam pressure from the cylinder, but the stems of the valves from the face of the valve to the other

PERSONAL

E. S. SPAETIG, who has been active in construction work at Hog Island, has been made superintendent of steel construction at the Groton Iron Works, Groton, Conn.

A. M. MAINE, naval architect, has been appointed general superintendent of the Groton Iron Works, Groton, Conn.

ALEX AFANASSIE is now inspector in the ship fitting department of the Submarine Boat Corporation, Newark, N. J.

J. A. RIDLEY, who recently resigned from the McDougal-Duluth Company to become naval architect at the Canadian Car & Foundry Company, Fort William, has accepted a position as hull inspector for the Emergency Fleet Corporation in the Ninth District.

A. MUHLHAUSER has been appointed chairman of the executive committee dealing with the employment problems of the Atlantic Coast Shipbuilders' Association. He is at present employment manager for the Baltimore Dry Docks & Shipbuilding Company, of Baltimore, Md.

WILFRED JESSUP has resigned as acting head of the labor supply division of the Emergency Fleet Corporation. The resignation became effective February 15.

ROBERT N. KING, head of the special dispatch agency of the Shipping Board, has tendered his resignation to return to private business. The agency has served to expedite transportation of cargoes through investigating and remedying delays.

CAPT. FRANK E. FERRIS, of San Francisco, has succeeded Capt. Charles Yates as the managing agent at the New York office of the division of operations of the United States Shipping Board.

CHESTER W. CUTHELL has resigned as general counsel of the United States Shipping Board Emergency Fleet Corporation. In his place, W. H. White, of Norfolk, Va., has been made general counsel.

AT THE ANNUAL MEETING of the Marine Engineers' Beneficial Association, on January 1, William S. Brown was again elected president. The other national officers elected were: First vice-president, J. S. Purdy, of San Francisco; second vice-president, William F. Hyman, of Baltimore, Md.; third vice-president, E. C. Killian, of New Orleans; secretary, George A. Grubb, of Chicago; treasurer, Albert L. Jones, of Detroit; executive committee, R. L. Goelet, representing the Atlantic coast; C. S. Folett, representing Pacific coast; William J. Garrett, the Great Lakes; E. C. Killian, the South Atlantic and Gulf; C. M. Sheplar, Western rivers.

K. H. SCHEEL, who has been actively engaged in the training of hull draftsmen on the Pacific Coast since the entry of the United States into the war, has received public recognition of the value of his work in the honorary resolutions, which were presented to him on January 28 by the men who had taken the course. His instruction has covered ship calculation, design and propulsion.

CAPTAIN HARRY GEORGE, who took command of the Mare Island Navy Yard during the activities of the last year, has again resigned from active service.

J. BRUCE ISMAY has presented £25,000 (\$100,000) to the English Mercantile Marine Service Association, as a mark of his appreciation of the work of officers and men during the war.

CAPTAIN WILLIAM D. SOUTHWICK has been appointed supervisor of recruiting stations for the United States Ship-

ping Board, with offices in Boston, the national recruiting service headquarters.

CAPT. JOHN L. ANDERSON, president of the Anderson Shipbuilding Corporation of Lake Washington, has been appointed superintendent of transportation, having jurisdiction over the county's fleet of ferries at Seattle.

RICHARD CONNELL, commander of the concrete ship *Faith*, has been appointed to the command of the big steel steamer *Triumph*, for the Bethlehem Shipbuilding Corporation.

E. E. PALEN, general agent of the Hampton Roads district of the United States Shipping Board, sailed for Europe for the purpose of surveying merchant marine conditions and arranging for the establishment of agencies abroad.

J. D. LOWMAN has resigned his position as assistant director of the Chief of Bureaus of the United States Shipping Board in the Northwest district. D. W. Burchard, his assistant, becomes his successor.

WILLIAM G. COXE, formerly president of the Harlan & Hollingsworth Corporation, Wilmington, Del., is now in charge of operations at the Gloucester City and Wilmington plants of the Pusey & Jones Company, succeeding Finn Hannevig, vice-president and general manager, recently resigned.

OBITUARY

PEMBROKE JONES, vice-president of the Carolina Shipbuilding Corporation, Wilmington, N. C., died on January 24, following an operation.

Wallace H. Roe, president of the Pittsburgh Steel Company, died on February 3. He has been a factor in the steel industry since 1886.



Farewell Luncheon in Honor of Axel Rossell, Assistant Naval Architect of the Emergency Fleet Corporation, Given by His Associates in the Engineering Section on February 8 at the Bellevue-Stratford. Alfred H. Haag, Chief Constructor, Presided, and the Speakers Were H. C. Sadler, Naval Architect; D. H. Cox, Manager Ship Construction Division, and Charles Piez, Director General